



## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

#### Table of Contents

---

##### Preface

- Why this manual was prepared.
- How the manual is organized.

##### Chapter 1: What is Integrated Pest Management?

- Introduction
- Plant Health Care and IPM
- Prevention
- Steps in a Landscape IPM Program
- Conclusion

##### Chapter 2: Moving from Theory to Practice

- Introduction
- Developing a Landscape IPM Program
- Manage for Success
- Educate and Communicate

##### Chapter 3: Preferred Pest Controls

- Introduction
- Mechanical and Physical Controls
- Biological Controls (Natural Enemies)
- Preferred Pesticides

##### Chapter 4: IPM for Vegetation

- Introduction
- Prevention

- Identification
- Monitoring
- Action Decisions
- Treatments
- Evaluation

#### **Chapter 5: IPM for Weeds in Turf**

- Introduction
- Prevention
- Identification
- Monitoring
- Action Decisions
- Treatments
- Evaluation

#### **Chapter 6: IPM for Insects in Turf**

- Introduction
- Prevention
- Identification
- Monitoring
- Action Decisions
- Treatments
- Evaluation

#### **Chapter 7: IPM for Diseases in Turf**

- Introduction
- Prevention
- Identification
- Monitoring
- Action Decisions
- Treatments
- Evaluation

#### **Chapter 8: IPM for Insects & Mites in Greenhouses & Nurseries**

- Introduction
- Prevention
- Identification
- Monitoring
- Action Decisions
- Treatments
- Evaluation

#### **Chapter 9: IPM for Insects & Mites in Ornamentals & Trees**

- Introduction
- Prevention
- Identification
- Monitoring
- Action Decisions
- Treatments
- Evaluation

#### **Chapter 10: IPM for Diseases in Ornamentals & Trees**

- Introduction
- Prevention
- Identification
- Monitoring
- Action Decisions
- Treatments
- Evaluation

#### **Chapter 11: Safe Use Guidelines for Landscape Pesticide Treatments**

- Precautions for Using Pesticides in Landscapes
- Public Land: Authorizations and Notification
- Private Land: Authorizations and Notification
- Professionalism and Pest Management

#### **Glossary**

#### **Answers to Study Questions**

#### **Appendices**

- I. Provincial Plant Diagnostic Lab Submission Form
- II. Examples of Forms Used in Landscape IPM
- III. Resources and Suppliers

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.





• Ministry Home

• Government of British Columbia

**Environmental Management Branch**Ministry of  
Water, Land and  
Air Protection[The Minister](#)[News](#)[Search](#)[Reports & Publications](#)[Contacts](#)

## INTEGRATED PEST MANAGEMENT

### Preface

### *Integrated Pest Management Manual for Landscape Pests in British Columbia*

Ministry of Environment, Lands and Parks  
(now Water, Land and Air Protection)

Pollution Prevention and Remediation Branch

By  
L.A. Gilkeson and R.W. Adams  
2000

#### *Disclaimer*

The information in this manual is supplied with the understanding that no discrimination is intended and that listing of commercial products implies no endorsement by the authors or the British Columbia Ministry of Environment, Lands and Parks.

Due to changes to labels, laws and regulations that occur over time, the British Columbia Ministry of Environment, Lands and Parks assumes no liability for the suggested use of pesticides contained herein.

**No pesticide can be used unless it is registered in Canada for the intended use and has a Pest Control Products Act registration number. At all times, pesticides must be applied according to the label directions on the pesticide container.**

#### **Acknowledgements**

The authors would like thank the following reviewers on behalf of the BC Landscape and Nursery Association, who provided valuable comment and correction on drafts of the manual:

Ron Brown, Ron's Landscaping Service Ltd.  
Allan O'Connor, Creative Garden Services Ltd.  
Lance Sharon, Upper Levels Landscape Management Ltd.  
Robert Welsh, Capilano College

The authors would also like to thank the following people for their important contributions in reviewing parts or all of the text:

Conrad Bérubé, Ministry of Environment, Lands and Parks  
Bob Costello, Ministry of Agriculture, Food and Fisheries  
Sophie Dessureault, Vancouver Parks and Recreation  
Joanne Edwards, Ministry of Environment, Lands and Parks  
Janice Elmhirst, Ministry of Agriculture, Food and Fisheries  
Gayle Jespersen, Ministry of Agriculture, Food and Fisheries  
Mario Lanthier, CropHealth Advising and Research  
Hugh Philip, Ministry of Agriculture, Food and Fisheries  
Jerry Vakenti, Ministry of Environment, Lands and Parks  
Madeleine Waring, Ministry of Agriculture, Food and Fisheries

Final manual layout and design, including the Internet versions, was done by Ian Black,  
Ian Black Concepts [ian@ianblack.com](mailto:ian@ianblack.com)

### ***Why This Manual was Prepared***

This manual is one in a series of IPM manuals for use in pesticide applicator training. It was produced by the Ministry of Environment, Lands and Parks to promote adoption of an Integrated Pest Management (IPM) approach in the landscape sector. The goal is to ensure that all pesticide are used only within an IPM program. Experience has shown that applying IPM methods eliminates unnecessary pesticide use, often reducing pesticide use by 60-80% in landscapes. At the same time landscape managers report better results than when they mainly relied on pesticides to control pests. This is not surprising because landscape IPM programs are based, first and foremost, on preventing pest problems by growing healthy plants in well-designed landscapes.

The landscape industry and those who work for parks departments and in other public landscapes are well aware of the trend in public concern about pesticide use. This concern has resulted in restrictions on pesticide use and even bans in certain jurisdictions. A 1999 survey of the BC turfgrass industry \* found that 88% of the survey respondents operated within some type of restriction on pesticide use. Over 17% of parks and school board respondents stated that they operated under a 'no pesticides' policy. Regardless of whether or not pesticide use is an option, an IPM approach can be used to provide beautiful turf and ornamental plantings. Today there are more effective alternatives to pesticides than ever before and more low risk pesticides registered for use in landscapes.

Lack of training is often cited as an obstacle to the wider adoption of IPM methods. The ministry is addressing this problem by incorporating IPM training in the learning requirements for pesticide applicator certification in the province. Candidates studying for applicator certification will be expected to have a good understanding of the information in this manual. This IPM initiative has widespread support in the professional landscape industry in the province. Providing IPM training for the landscape sector is endorsed by BC Landscape and Nursery Association, whose members have been instrumental in production of this manual by reviewing the texts and providing information and suggestions.

This manual describes the basic principles of IPM as they apply in landscapes and gives examples of IPM programs for common pests. It is intended to be a training manual as well as a basic reference guide for pest management. It may also be useful for Master Gardeners, landscape designers and clients of landscape services who want to know more about IPM and least-toxic treatment methods.

Given the wide variety of ornamental plants and climates found in the province, this manual is not intended to cover every pest problem that can appear in landscapes. Rather, it is intended to provide landscape managers with the basic information they need to apply IPM methods to the landscapes under their management. Every IPM program must be tailored to suit a specific site as well as the needs of those who use the site. Each chapter contains a list of suggested references that provide

more information. We hope that readers will be stimulated to go on and investigate this fascinating subject in greater depth and will continue to keep up with new developments in the field.

This is our first IPM manual for the landscape sector in BC so there may be unforeseen omissions and errors. We would appreciate receiving comments that will help us improve future editions of this manual.

\* Summary in: The Turf Line News, June/July 1999, vol. 152:8-15

### ***How the Manual is Organized***

**Chapters 1 to 3:** The first chapter in the manual gives an overview of IPM as it applies to landscapes, while the second chapter describes practical ways to apply this information in developing an IPM program. Chapter 3 contains information on specific physical, mechanical and biological controls and reduced risk pesticides that are referred to in later chapters.

**Chapters 4 to 10:** These chapters describe how IPM methods can be applied to different types of sites and pest problems commonly found in BC. Each chapter includes notes on prevention and outlines identification, monitoring methods, action decisions, range of treatment options and evaluation methods. Notes on IPM programs for specific pests are included at the end of some chapters.

**Chapter 11:** The final chapter describes precautions for using pesticides in landscapes. It also includes recommendations on communications between landscape managers and their clients or public.

---

[Back to Table of Contents](#)

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.



[• Ministry Home](#)[• Government of British Columbia](#)**Environmental Management Branch****Ministry of  
Water, Land and  
Air Protection**[The Minister](#)[News](#)[Search](#)[Reports & Publications](#)[Contacts](#)

## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

#### Chapter 1 — What is Integrated Pest Management?

##### **Learning Objectives**

When you have completed this lesson, you should be able to:

1. Define the term 'Integrated Pest Management'.
2. Describe the advantages of IPM programs over scheduled pesticide spray programs.
3. Describe the role of prevention and describe how to design landscapes to prevent pest problems.
4. List the five main steps in an IPM program for an existing pest problem.
5. Describe the importance of identifying pests and knowing their biology.
6. Describe the role of monitoring in an IPM program.
7. Describe the difference between an injury level and an action level in an IPM program.
8. Name and describe five types of treatments used in landscape IPM.
9. Describe problems arising from the use of pesticides to control pests.
10. List items to record in evaluating the success of a pest control program.

##### **Introduction**

The intent of this chapter is to clarify what is meant by Integrated Pest Management (IPM), as it applies to landscape pests. IPM is an approach that uses a combination of techniques in an organized program to suppress pests effectively, economically and in an environmentally sound manner. Think of it as a way to manage landscapes to prevent problems and to make decisions about managing pests (for a detailed definition of IPM, see text box).

Note: Throughout this manual we use the general term "pests" to include insects, weeds, disease organisms, birds, mammals and other organisms that can become a problem.

IPM is an approach that has been used for decades to manage insects and mites in agricultural crops. Over the last two decades, however, IPM methods have also been successfully applied to

manage pests of all kinds, including weeds, plant diseases and animals. IPM programs are used in agriculture, forestry, landscapes and parks, home gardens and for structural pests. Most major BC municipalities (e.g., Vancouver, Victoria, Burnaby, Coquitlam, Nanaimo, Penticton, Kelowna, and others) have IPM policies for their landscapes, some dating back to 1990.

**General definition of Integrated Pest Management**

Incorporated in the *Pesticide Control Act* (British Columbia) in 1997.

Integrated pest management means a decision making process that uses a combination of techniques to suppress pests and that must include but is not limited to the following elements:

- (a) planning and managing ecosystems to prevent organisms from becoming pests;
- (b) identifying potential pest problems;
- (c) monitoring populations of pests and beneficial organisms, pest damage and environmental conditions;
- (d) using injury thresholds in making treatment decisions;
- (e) reducing pest populations to acceptable levels using strategies that may include a combination of biological, physical, cultural, mechanical, behavioural and chemical controls;
- (f) evaluating the effectiveness of treatments.

In an IPM program, pest managers use regular inspections, called monitoring, to collect the information they need to make treatment decisions. A central idea in IPM is that a treatment is only used when pest numbers justify it, not as a routine measure. Applying pesticides according to a schedule based on calendar dates is rarely, if ever, done in IPM programs. This eliminates unnecessary pesticide use without sacrificing results. It is common to find pesticide use reduced by 60-80% when IPM programs are put in place. For example, since IPM was adopted by the US National Parks Service in the early 1980s, pesticide use has been reduced by over 60%. In addition, parks managers found that they achieved better control of pests. Taking unnecessary pesticide use out of a pest management program also reduces the chance that pest populations will become resistant to pesticides (more on pesticide resistance).

Another important idea in IPM is that it is only necessary to keep pest numbers down to non-damaging levels. It is usually not necessary, or even desirable, to eliminate pests. If treatment is needed, pest managers choose the combination of methods that suit the site and local conditions. As this chapter describes, however, an IPM program is much more than a combination of treatments.

In the short term, developing an IPM program may cost more for labour and for changes in equipment and site designs. Experience has shown, however, that in the long-term, IPM programs can be more cost effective because they prevent future problems, improve the quality of a landscape, and reduce costs related to pesticide use (i.e., for applicator certification, spray equipment, pesticide storage facilities and disposal). IPM provides a way to manage pests that have become resistant to pesticides and to deal with pests in places where pesticides cannot be used. It is important to realize that IPM programs change and improve as people gain experience, and as new products, tools and information become available.

In summary, the advantages of IPM programs are that they:

- provide long-term solutions to pest problems,
- protect the environment and human health by reducing pesticide use,
- reduce costs and liabilities associated with pesticide use,
- prevent pesticide resistant pests from developing,



- enable pest managers to control pesticide resistant pests, and
- give good results where pesticides cannot be used.

• Top

## ***Plant Health Care and IPM***

Prevention is the true foundation of an IPM program. The key to successful and economical IPM in landscapes is preventing pest problems, mostly by growing healthy plants. An increasingly popular system of managing plants, called Plant Health Care™ (PHC), is one such broad approach to plant management (see Further Reading at the end of this chapter). It emphasizes managing a healthy plant ecosystem and working with nature to provide a flourishing landscape. The excellent results achieved by applying PHC principles often eliminate pest problems entirely.

Many methods and principles are common to IPM and Plant Health Care, so whether you call a pest management program PHC or IPM is not important. What is important is learning to think of growing healthy plants as the key to preventing pest problems. Rather than accepting pest attack as inevitable, progressive landscape managers see a pest problem as a sign that there is an underlying plant health problem they need to address.

## ***Prevention***

Since the real beginning of an IPM program should be prevention, it is discussed first in this chapter. Following that, the steps in an IPM program for an existing pest problem are described in general. They are described in more detail in later chapters on IPM programs for specific sites (see Chapters 4 to 10).

Anything that can be done to prevent pest problems makes it easier and cheaper to maintain the appearance and function of the landscape in the future. Most prevention consists of the type of planning and management that produces healthy plants (some references call these practices 'cultural controls'). At its most basic, this means choosing the right plants for the site and giving them the best growing conditions.

Examples of factors to consider in designing a landscape and to improve, if necessary, are:

- soil conditions, including fertility, drainage, pH and organic matter
- facility design, such as planters and beds, irrigation systems, walkways that prevent weed growth
- plant selection, for cultivars resistant to pests and adapted to the climate and sitetaking into account sun and shade conditions, winter temperatures, winds and patterns of use
- plant diversity, by choosing a variety of plant families, species and cultivars; this avoids monocultures, which are more likely to suffer pest outbreaks
- plant care, such as transplanting methods, spacing, watering, fertilizing, pruning, staking, mowing practices



*Poor bed design jeopardizes tree health*

Ideally, the people responsible for managing a landscape would work with the site planners to choose trouble free plants and "design in" good growing conditions. Most of the time, however, landscape managers take on established sites. These may contain poorly designed facilities or plants with chronic pest problems. The following steps present a process for managing existing pest problems using IPM methods. Once immediate pest problems have been dealt with, however, the landscape manager should look for ways to correct the underlying conditions that led to the problem. This might mean developing a long-term plan to replace problem plants, rebuild sports fields, redesign planters or make other changes.

[Top](#)

### ***Steps in a Landscape IPM Program***

An IPM program to treat an existing pest problem involves five main steps:

IDENTIFICATION — identify the pest

MONITORING — monitor the pest population and/or damage

ACTION DECISIONS — use injury and action levels to decide when to treat

TREATMENTS — apply a variety of controls

EVALUATION — evaluate results, plan improvements

#### **IDENTIFICATION**

It is essential to identify pest problems correctly to plan effective pest management programs. First, it is important to identify whether or not there is a pest problem. In landscapes, plant damage is more likely to be caused by environmental conditions that stress or injure plants (such as drought, flooding, nutrient deficiency, sunscald, frost, salt or wind burn, dog urine, or mechanical damage), than it is from pests.

Once a pest has been identified, the pest manager can look up information on its biology, including life cycle, behaviour, preferred habitat and typical host plants. Knowing about the biology of a species helps to:

- concentrate monitoring efforts when and where pests are most likely to occur,
- use treatments at the right time in the pest life cycle,
- know if the pest has natural enemies that could be conserved or protected, and
- plan preventative measures and improve plant management practices.

It is very important to identify beneficial insects and other natural enemies. This is because they are often mistaken for pests (and sprayed accordingly!) when they are really feeding on the pests. Knowing what beneficial species look like also helps in deciding whether or not controls are necessary. There may be enough natural enemies among the pests to control them in a few days without need for further action.

To identify problems, you usually need to collect insect specimens or samples of plant damage so that they can be compared with reference materials. Tips on where to look and how to sample for common pests are included in Chapters 4 to 10. Before sending samples to identification services,



contact them for their recommendations on how to collect and handle samples.

How to identify pests and beneficial species:

- compare specimens with an insect or weed collection
- refer to reference books, fact sheets or resources on the Internet
- consult experts for help with difficult or unfamiliar species
- compare characteristics of damage or signs of disease with photographs

Be careful when using characteristics of plant damage to diagnose problems because similar looking damage can have different causes. For example, curled leaves caused by a virus can look like damage caused by thrips, aphids or some kinds of mites. If the symptoms were caused by a virus it would be useless to spray an insecticide or release aphid predators.

#### **Make Your Own Collection**

It is often easier to identify an insect or a weed by comparing it to a real specimen than it is to use pictures. We recommend that pest managers make their own collections of insects (pests as well as beneficial species) and pressed weeds. These are useful for quick reference and for training employees. It is also a good idea to keep a photograph collection of pests, damage and disease symptoms for future reference.

**Note:** Provincial government staff do not provide identification services to the general public, however, landscape businesses and agencies can send specimens to the provincial Plant Diagnostic Laboratory (Ministry of Agriculture, Food and Fisheries, 1767 Angus Campbell Rd., Abbotsford, B.C. V3G 2M3; Phone: 604-556-3126) for identification and recommendations. There is now a fee for this service. Contact information and a lab submission form are included in Appendix I.

[• Top](#)

## **MONITORING**

Monitoring consists of making regular inspections or counts and writing down the results. Pest managers need monitoring records to make decisions about whether treatments are needed and when. Such records show where the pest problems are, and whether they are getting better or worse.

Monitoring is used to:

- detect problems while pest numbers are still low
- assess the size and spread of a pest population and extent of damage
- find out if natural enemies of pests are present and in what numbers
- look for conditions that contribute to the pest problem
- find out what effect treatments or natural enemies have had on the pest population

A monitoring program consists of:

- a series of inspections or counts, done at regular intervals, and
- written records of the observations and counts.

Always write down counts and notes at the time they are made so that the information is accurate.

Using a well-designed record sheet makes it easy to enter information, saves time and makes sure important information is not left out (for examples, see Appendix II). For efficiency, some companies have staff enter records into a portable computer at the site. Such records can be quickly added to the company's database.

**When and Where:** The time and place to start monitoring depends on the site, the plants and the pest involved. By learning about the life cycle of various pests, you will know what plants they are most likely to attack and when. For example, an ideal time of year to look for tent caterpillars (*Malacosoma* spp.) is April, when the hatching egg masses are easy to see on bare branches. There is no point in continuing to monitor for tent caterpillars in mid-summer, because by then the caterpillars have left the trees.

**How Often:** Frequency of monitoring varies with the pest and conditions. For example, weeds in turf may be counted once or twice a year, whereas monitoring for insects is often done weekly during the time of year they are expected to appear. Monitoring for fungal diseases in turf might be necessary every day or two in damp weather.

**What to Record:** Examples of information to record include:

- species of plant and location
- weather conditions, such as temperature and humidity
- counts of pests and beneficial species
- counts or notes of damage or symptoms
- notes on site conditions that may be relevant
- growth stage of other plants in the area (called phenology, see below)

Not all of this information is useful in every case. With experience it will be possible to narrow down what information is most useful and suited to the situation.

Landscape managers have come up with short cuts that narrow down when, where and what to monitor, using:

**Plant Phenology:** Phenology is the relation between climate and biological events — in this case, plant development, such as blooming, leafing out, etc. Plant growth depends on temperature, so the date a particular plant blooms depends on how the weather has been. Although the calendar dates may differ from year to year, plants generally develop in the same relationship to each other. For example, wild cherries bloom before lilacs, which bloom before horse chestnuts; particular cultivars bloom earlier or later than others. Since insect development also depends on temperature, it can be more accurate to relate the appearance of particular insects to plant phenology than to a calendar date. For example, you may discover that aphid populations always seem to develop on poplar in the area at the same time horse chestnuts in the area begin to flower. Using plant phenology as a rough guide (it isn't perfect) helps you target monitoring to the most likely time to expect the pest.

**Indicator Plants:** With experience and by keeping good records, you can pinpoint individual plants or particular cultivars or species that are most likely to have a pest problem year after year. Records may also show that there are sites where pests problems show up first in the area, often because they are warmer or more protected than other sites. Plants that are the first to show a problem can be used as indicator plants to focus monitoring efforts. They would be checked first and, as long as they remain pest-free, there would be no need to spend time monitoring other plants.

**Key Pests:** Because of the wide variety of trees, shrubs and herbaceous plants grown in landscapes, there are many potential pests. In practice, however, there are usually only a few that can be seriously damaging or that appear every year. For example, a 1986 survey of nearly 3000 municipalities in the US found that a group of 10 insects accounted for three-quarters of all the insect problems in their landscapes. Knowing which pests are of the most concern can help the pest manager to focus their monitoring on the most important problems. Information on the most common landscape pests in BC is provided in Chapters 4 to 10 of this manual and in the references listed

under Further Reading.

• Top

**Monitoring Methods:** There are many different techniques for monitoring pest numbers and activity. These can be divided into two main approaches: visual inspections and counting methods. As there are many ways to count pest populations, only some examples of the most common counting techniques are described below. For details on other methods, see Monitoring sections in Chapters 4 to 10.

**Visual Inspections:** A visual inspection is a good, close look, often through a magnifying lens (and done at regular intervals, while keeping notes, of course). This is the most common monitoring method used in landscapes because specific sampling methods have not been developed for the variety of plants and pests that are possible in landscapes.

Visual inspection is the most subjective monitoring method. This means that what is seen and recorded depends on the knowledge, skills (and opinions) of the person doing the looking. Visual inspections are most useful when all you need to know is whether or not pests or beneficial species are present. They are also useful in checking plant health, soil and moisture conditions and for quickly finding problem sites, such as unusually weedy patches in turf.



*Using a hand lens*

#### **Tool for Visual Inspections**

- 10 - 15 X magnifying lens or headband magnifier or dissecting microscope
- vials or plastic bags (to hold samples to be examined later under a microscope)
- note pad or pre-printed forms, pencils
- pocket knife, pruning shears and/or a pole pruner (for collecting samples from tall trees)
- small trowel or soil probe for checking soil conditions

**Counting Methods:** Counting methods for monitoring pest populations are well developed for only a few problems, such as weeds in turf (aided, no doubt, by the fact that weeds hold still for counting!). The advantage of using counts in monitoring where ever possible is that they give numerical (quantitative) measurements. Unlike visual inspections, such measurements give numbers that can be compared from year to year as long as the same method is used each time.

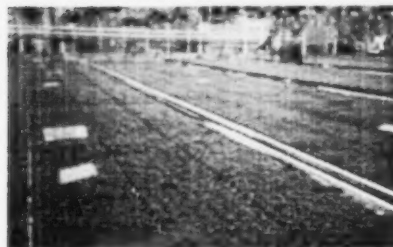
For example, you could count the number of:

- insects per leaf, per stem, or in an area of turf
- weeds in a measured area of turf, or along a length of roadside or sidewalk
- disease spots per leaf or area of turf
- spots of aphid honeydew on sampling cards placed under trees
- insects caught in sticky traps

- insects that drop into beating trays when a tree trunk is struck

**Insect Traps:** Several types of traps are available for monitoring insect populations. Examples used in landscape ornamentals are sticky traps and pheromone traps. Traps are usually checked weekly and the number of insects caught are counted and recorded. Traps are used to:

- find out when the first adult insects are present, and
- estimate the size and extent of a pest population.



*Sticky Traps*

**Sticky Traps:** Some insects are attracted to bright yellow or other colours, which makes it possible to catch them on coloured cards coated with sticky glue. Yellow sticky traps attract adult whiteflies, flower thrips and fungus gnats. Bright blue traps are also available for flower thrips. Such sticky traps are usually used as a monitoring tool in greenhouses, although they can also be used as a control (see Physical Controls, below). Some shades of yellow sticky traps can also catch beneficial insects, therefore their use is limited outdoors.



*Wing trap using pheromones*

**Pheromone Traps:** Most pheromone traps contain synthetic sex pheromones that mimic the odour given off by female moths to attract males for mating (see text box on semiochemicals). Pheromones are so specific that a different pheromone (or blend of pheromones) is needed for each species. This makes them an excellent monitoring method because they mainly catch just the target insects. The traps are used to find out when the main flights of adult moths occur so that sprays or biological controls can be used at the right time to have the greatest effect.

The pheromone is usually contained in a rubber or plastic lure that is hung inside a cardboard trap, such as a wing trap. The inside of the trap is coated with sticky glue, which catches the insects that enter. To inspect the trap, the pest manager opens it up and counts the captured insects.

#### **Semiochemicals: How Insects Communicate**

Semiochemicals, meaning literally "message chemicals", are chemical compounds that insects use as signals. These include compounds given off by plants that attract or repel insects as well as message chemicals produced by the insects. Semiochemicals that insects use to communicate with members of their own species are called pheromones. For example:

- sex pheromones are emitted by females to attract males
- aggregation pheromones are emitted to attract others
- alarm pheromones are emitted to warn others

Sex pheromones are most commonly used in monitoring for a wide range of moth species. An increasing number of other semiochemicals are becoming available to manage other pests by affecting their behaviour. Semiochemicals are being used to disrupt mating in insects, to trap them in large numbers, to attract them to toxic

baits or to lure them to places where other treatments can be used.

[Top](#)

**Beating:** Some insects that would be very hard to find among the leaves of trees or shrubs are easy to knock from the plant by striking the trunk with a padded stick. You can catch any insects that drop by holding a beating tray (usually a square of light-coloured fabric on a frame) under the branch while striking the limb or trunk. The insects can be identified and counted on the spot, or held in sample bags and counted later. Mites and small insects can be sampled by tapping the foliage over a clipboard covered with light or dark paper.

For consistency, the same number of taps or beats should be used for each sample so that the results can be compared between plants or from one date to the next.

**Reliability of Counting Methods:** The point of counting pests (or pest damage, beneficial species, etc.) is to get an accurate as possible picture of the pest situation. Two main factors determine how reliable counts are in showing the true state of the pest population. These are: sample size and sample randomness.

**Sample Size:** To be meaningful, it is usually necessary to count between 10 and 50 samples (such as insects on leaves or weeds in squares of turf) and average the results. The more samples you take, the more likely it is that the average will be a true picture of the pest situation, but there is a practical limit, because time spent on monitoring is a labour cost. A way to determine how many samples is enough, is described in the text box.

#### How Many Samples are Enough?

Sampling involves statistical theory, and can get very complex. Luckily, for most landscape pest monitoring, a reasonably good estimate will do. Here is one way to estimate how many samples to take:

First:

- take 10 samples and count the pests (e.g., aphids on rose leaves, number of weeds/metre<sup>2</sup>)
- add up the total number of pests in the samples and divide by 10 to get the average

Second:

- take 40 samples, count the pests, add up the total and divide by 40 to get the average
- compare the average of 10 samples with the average from 40 samples

If the averages are the same or pretty close (within 10-20% of each other), it shows that the higher number of samples probably wasn't necessary; taking 10 samples is likely to be enough. If there is a bigger difference between the two averages, however, it means you probably need to take more samples. Try the average of 15 or 20 samples to see if the averages are closer to the 40 sample average.

(Adapted from: Daar, S., H. Olkowski & W. Olkowski. 1992. IPM Training Manual for



Wholesale Nursery Growers. Bio-Integral Resource Center, CA)

**Sample Randomness:** It is usually necessary to make sure that samples are picked at random. This means picking them by chance, without looking at them first and deciding which to take. If you intentionally choose particular leaves or other units to count, the results likely won't give a good estimate of the pest situation. For example, one way to count weeds in a lawn is to lay a 1-metre-square frame on the grass and count the number of weeds inside. If you chose the only weedy spot in the lawn, your records would seem to show the whole lawn was full of weeds. If you chose the only weed-free area on a lawn, the opposite would appear to be true. Only by dropping the frame randomly on the lawn a number of times and calculating the average weed count, would the results be likely to tell you the average weed infestation in the lawn.

One way to take a sample randomly, in the case of the turf example, above, would be to close your eyes, walk a few steps, drop the frame and count the weeds wherever it landed. Another way to ensure randomness is to decide a pattern of sampling ahead of time and stick to it. This removes the temptation to choose where to take a sample after you see the site. For example, you could decide to count the aphids on every 5th branch tip or every 5th plant in a row; you could lay out a grid pattern on turf and count the weeds only at the intersection points.

Ensuring samples are random doesn't mean that you have to sample over a wide area or in places where the pest are not likely to be. It is most efficient to concentrate on sites, plants or parts of plants, where the pests are most likely to appear (a good reason to learn about their biology). For example, to monitor aphids in the spring, inspections would start with growing tips and plant shoots. If you just want to know whether or not aphids have arrived, this non-random checking would be fine. If you want to know the average number of aphids per shoot, or the average number of shoots that have aphids, then you need to take random samples and average them. You could still target your sampling to plant shoots and tips to make it most efficient, but you would take samples randomly from among all the possible shoots and tips.

*Note:* It is meaningless to compare counts from random sampling with counts from non-random sampling. The same sampling methods must be used each time if you want to be able to compare results from one week to the next, or from year to year.

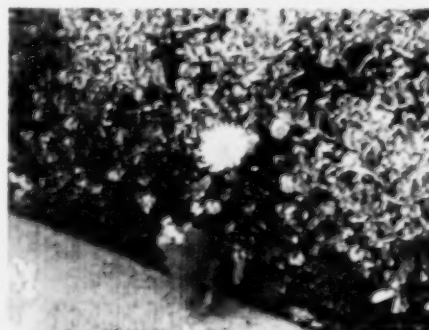
• Top

## ACTION DECISIONS

In IPM programs, determining when to apply treatments really involves two concepts. In most descriptions of IPM programs, these are called:

- injury level (or injury threshold), and
- action level (or treatment threshold)

The injury level is the level of the pest population that causes an unacceptable amount of injury or damage. A few aphids on a tree or a weed or two in a lawn are not a problem, but at some point, the numbers could reach a



level that is intolerable. This is the injury level; it depends on such factors as:

- what part of the plant is affected
- what pest is involved and the risk of permanent injury or death to the plant
- overall health of the affected plant (vigorous plants tolerate more damage)

- location of the plant in the landscape
- attitudes and perceptions of people who use the site
- cost and effectiveness of treatments

There are generally only a few pest problems, such as boring insects, root weevils and some plant diseases, that are life threatening to landscape plants. Most pests damage the appearance of plantings, often only temporarily. Since landscape plants, however, are grown to provide pleasing surroundings, the visibility of the damage will be important in setting an injury level. For example, even slightly damaged roses in front of city hall would be noticed, while heavily damaged leaves at the top of a tree in a naturalized park probably would not.

#### **What is a Pest?**

In IPM programs, the term "pest" is usually used as a characteristic of a population of organisms. This means that individuals of a species are not usually "pests". They only become pests when there are enough of them, in the wrong place. For example, masses of dandelions growing along a roadside are a valuable source of pollen for bees, but a few dandelions growing in a display bed or fine turf are considered pests. Aphids can benefit plants by helping to harden off succulent tree growth in the fall, but when large numbers of aphids in street trees drop honeydew onto cars below, people consider them a major pest problem, even though the trees are usually unharmed.

Because aesthetics are involved, the attitudes and values of the site users play a large part in setting injury levels. These perceptions can change through education. For example, when someone learns about the benefits of clover in lawns (i.e., it adds nitrogen to the soil and is drought tolerant), their attitude can shift from wanting to get rid of clover to appreciating it. When people know more about pest biology, their tolerance of cosmetic damage can also increase. For example, if people know that trees will soon replace the leaves damaged by tent caterpillars, they are less likely to feel they need to spray to protect the trees.

The action level or treatment threshold. This is when a particular control should be applied to keep the pest numbers from reaching the injury level. When to take action depends on factors such as:

- how fast the treatment works
- what growth stage of the target organism the treatment acts upon
- time of year or weather conditions that affect the treatment
- cost of negative side effects of treatment (such as loss of beneficial insects that might be controlling other pests)

You need to know what kinds of treatments are going to be used before you can set an action level. This is because how the treatment works will be a factor in deciding when to use it. For example, chemical insecticides are generally fast acting, so the most cost effective time to apply them might be just before insect populations reach the injury level. In practical terms, when pesticides are used to treat a landscape pest problem, the injury and action levels are often considered to be about the same. Most biological controls agents, on the other hand, usually need time to reproduce and build up their numbers, so they would be released well before the pest population reaches damaging numbers.

Other examples of treatment characteristics that affect when they can be used are:

- herbicides that work only on actively growing plants
- microbial sprays that only work on the caterpillar stage of moth pests

- oil sprays that can only be used on dormant trees

To decide whether or not treatment is required, you would compare the records from a regular monitoring program to the action levels you have established. Often there is no need to take any action, either because the expected pest is not found or because it remains at numbers well below the action level. When pest numbers rise higher it may be clear when they are reaching action levels and that treatment is needed. Sometimes, however, it is necessary to monitor more often or more widely to be able to make a decision.

• Top

---

## TREATMENTS

Ideally, treatments are only needed where preventative measures have not solved a pest problem. Often, however, an IPM program starts with an existing pest problem that must be dealt with before the landscape manager can plan a prevention program. Controls used in landscapes fall under five general types:

- cultural
- physical
- mechanical
- biological
- chemical

Other categories could be added to the list, especially as research develops new treatments. In agriculture and forestry, insect semiochemicals (see text box, pg.7) have been developed to affect insect behaviour on a large scale so these are often called behavioural controls. Some methods fit into two categories (i.e., sanitation can be considered either a cultural or a physical control). Therefore, categories aside, the important thing to know is that pest managers have a wide variety of treatment "tools". These can be used separately, or in combinations, to give the required level of control. Using a combination of treatments is usually more effective than relying on any one treatment. This is because each measure contributes to reducing the pest population even if the effect of each measure is small, all together they add up to effective control.

In choosing treatments, select methods that are:

- least hazardous to human health
- least toxic to nontarget organisms
- least damaging to the environment
- most likely to produce long-term results
- most cost-effective over time

### Cultural Controls

Cultural controls include many of the methods discussed under Prevention that are aimed at producing healthy plants. Sanitation methods are also generally included as cultural controls.

**Sanitation:** This mainly involves removing potential breeding sites for pests and destroying sources of infection. Examples include:

- Pull weeds that act as hosts for insects and diseases around nurseries and greenhouses.
- Correct drainage problems in greenhouses to remove breeding sites for fungus gnats.



- Remove trash and plant debris that harbour rodents, overwintering insects or disease organisms.
- Cut weeds before they set seed and spread to other areas.

• [Top](#)

## Physical Controls



*Removing tent caterpillars*

Physical controls include manual techniques, such as hoeing or pulling weeds and pruning out branches with tent caterpillar nests or fungus infections (this could be considered a sanitation practice). Some controls can be considered as either physical or mechanical, therefore they are usually grouped together in the Treatment sections of Chapters 4-10 of this manual. Physical controls also include passive techniques, such as barriers and traps.

**Barriers:** These simply stop pests from reaching their food supply. Examples include:

- Insect barriers, such as screens on greenhouse vents or floating row covers on nursery plants.
- Weed barriers, such as mulch mats, landscape fabric or mulches of leaves or bark that smother germinating weeds (discussed in more detail in Chapter 3).
- Animal barriers, such as deer fences, bird mesh or copper strips to keep out slugs.

**Traps:** These attract and catch pests, removing them from the population. The same type of sticky traps used to monitor for insects can be a physical control when they are used to catch a large part of the pest population. Examples include:

- Sticky tree bands catch female winter moths crawling up tree trunks before they can lay eggs.
- Sticky yellow traps catch adult whiteflies or fungus gnats in greenhouses.
- Baited traps catch slugs, yellowjackets, flies or rodents.

## Mechanical Controls

Mechanical controls are machines or devices used to control pests, such as vacuum equipment for insects and cultivators, mowers and line trimmers used to control weeds. Other examples include:

- Heat applicators, such as propane flammers, hot-water or steam applicators and infra-red radiation equipment, used to kill weeds growing in cracks in hard surfaces, under fence lines and along roadsides.
- Animal repellents, such as devices that squirt water when activated by a motion sensor to frighten deer, raccoons and other animals.

## Biological Controls

Biological control is the use of natural enemies of pests to control pest

populations. Many are beneficial insects and mites, but they can also be larger animals, such as birds and snakes, and microorganisms, such as fungi and bacteria.



*Infra-red weeder*

Landscape managers employ biological control by:

- protecting and attracting the many natural enemies that are native to BC, and
- using natural enemies from commercial suppliers.

**Protecting Natural Enemies:** The most important way to protect beneficial species is to avoid using pesticides as much as possible, especially those that affect a wide range of species or that are very long lasting. If pesticides are needed as part of a pest management program, then:

- choose the most selective products with the lowest toxicity and/or shortest residual effect, and
- limit applications to only those plants or areas that are infested.

**Attracting Natural Enemies:** Native beneficial insects can be attracted to landscapes by plants that provide them with pollen and nectar. Many female beneficial insects need to eat pollen or nectar in order to have enough energy to lay eggs. Once the females are attracted to the area, they are likely to stay and lay eggs. When the eggs hatch, the larvae attack the pests. Studies in agricultural crops have shown that providing flowering plants for beneficial insects results in better control of pests. In landscapes with few flowering plants, or where mainly showy flowers with little or no nectar are grown (e.g., roses, geraniums, etc.), it is a good idea to include some plants for the beneficial insects (see text box).

Many annual and perennial ornamentals are good insect plants. For example, yarrows, various daisies and calendula are good pollen sources for lady beetles. Making the landscape attractive to beneficial insects can be as simple as providing an edging of sweet alyssum around a rose bed or adding a few good insect plants to a display garden.

#### Plants that Attract Beneficial Insects

Many attractive plants for beneficial insects are in the carrot family (*Apiaceae*), mustard family (*Brassicaceae*), mint family (*Lamiaceae*) and aster family (*Asteraceae*). Some of these are weeds, herbs and vegetables — but there are many excellent ornamentals, including:

Alyssum  
Aster  
Basket-of-gold (*Aurinia saxatilis*)  
Beebalm (*Monarda*)

Marigolds (*Tagetes*)  
Mignonette (*Reseda odorata*)  
Phacelia  
Potentilla

|                                                       |                                               |
|-------------------------------------------------------|-----------------------------------------------|
| <i>Calendula</i>                                      | <i>Rudbeckia</i>                              |
| Candytuft ( <i>Iberis</i> )                           | <i>Salvia</i>                                 |
| <i>Ceanothus</i>                                      | <i>Schizanthus</i>                            |
| Common heliotrope ( <i>Heliotropium arborescens</i> ) | Shasta daisy ( <i>Chrysanthemum maximum</i> ) |
| <i>Coreopsis</i>                                      | Speedwell ( <i>Veronica</i> )                 |
| <i>Cosmos</i>                                         | Stonecrops ( <i>Sedum</i> )                   |
| Feverfew ( <i>Chrysanthemum parthenium</i> )          | Sweet alyssum ( <i>Lobularia maritima</i> )   |
| Golden marguerite ( <i>Anthemis tinctoria</i> )       | Thymes ( <i>Thymus</i> )                      |
| Lavenders ( <i>Lavendula</i> )                        | <i>Verbena</i>                                |
| <i>Lobelia</i>                                        | Yarrows ( <i>Achillea</i> )                   |

• Top

**Using Commercial Natural Enemies:** Beneficial species sold by commercial suppliers for use in landscapes include microorganisms ("microbials") and nematodes as well as insects and mites. These are discussed in more detail in Chapter 3 of this manual.

- The most widely used microorganism is *Bacillus thuringiensis kurstaki* (BTK), which is used to control caterpillars. Microbial products are legally registered as pesticides.
- Insect parasitic nematodes, which are microscopic worms that attack insects, are available in commercial products. The nematodes are mixed in water and applied to the soil to control root weevil larvae, leatherjackets and other turf and nursery pests.
- Most species of beneficial insects and mites are sold to control pest insects and mites in commercial greenhouses; only a few are recommended for use outdoors.

Pest managers interested in buying natural enemies should be aware that:

- Most only attack particular species of pests, therefore the pest must be correctly identified first.
- Supplier instructions must be followed carefully to ensure good results.
- These living organisms are very perishable. They must be handled with care and released promptly.

## Chemical Controls

A large variety of chemicals (and some microorganisms), are registered as pesticides in Canada. Pesticides are any substances used to kill, control, repel, or manage insects, rodents, fungi, weeds and other living things considered to be pests. Pesticides vary greatly in their toxicity and the way they work. In IPM programs, pesticides should only be used after careful assessment shows that they are the best control for the situation. Applying pesticides only when monitoring shows that the action level is reached is economical and eliminates unnecessary pesticide use.

Note: ONLY pesticides with a *Canadian Pest Control Products (PCP) Act* registration number on the label may be used for pest control. Pesticide products may only be used for pests and in locations specifically listed on the label. Always read the label before using any pesticide product.

When a decision is made to use pesticides, pest managers must choose the most suitable formulations and methods of application. They must take all possible precautions to prevent the exposure of people and nontarget organisms to the pesticide. Ways to limit negative effects of

pesticides include:

- choose "preferred pesticides" where possible (see below)
- choose application methods that limit the amount of pesticide used
- limit treatments to only the plants or sites where pests are a problem
- notify anyone who might enter a treated area so that they can avoid exposure

### Preferred Pesticides

Preferred pesticides, as described in this manual, are generally those that:

- present the least short- and long-term health risk to humans
- have the lowest environmental impact, usually because of short residual effects or because they specifically affect target pests.

The characteristics of specific preferred pesticides are described in Chapter 3 of this manual.



*Lance applicator for herbicide*

### Other Pesticides

Products containing toxic and/or persistent chemicals, such as organophosphate and carbamate insecticides are registered for some landscape pests. These may be necessary in some cases, particularly as a short-term measure. Generally, however, these products should not be used when preferred pesticides or non-toxic methods are available. This is because there is greater risk of harming non-target organisms and the hazards associated with improper storage and disposal are higher with these products than with preferred pesticides.

It is worth noting that federal review processes for organophosphate pesticides in the US and Canada are underway. This may result in restrictions on some commonly used products within a few years.

[• Top](#)

### Problems with Pesticide Use

Much of the interest in promoting IPM is a result of problems with using pesticides, including:

- development of pest populations that are resistant to pesticides
- development of new pest problems when the natural enemies that were keeping them in check are destroyed by pesticides
- exposure of humans, pets and other non-target organisms to pesticides
- environmental contamination with pesticides

In comparison to other types of controls used in IPM programs, pesticide use:

- provides short-term control, but rarely a long-lasting solution to pest problems
- requires effort and expense for service companies to provide adequate training, safety equipment and pesticide storage facilities
- requires careful planning and use of application techniques that protect people and the environment

- causes inconvenience (and concern) to site users who want to avoid treated areas

### **Pesticide Resistant Pests**

Pesticide resistant pest populations are a major problem in agriculture and, to a lesser extent, in other sectors. Resistance appears when a pest population is repeatedly treated with the same pesticide. A few individuals in the population may survive a spray because they have genetic characteristics that make them resistant. When they breed, they produce offspring that are more likely to survive the next time the pesticide is used. As each spray kills the susceptible individuals, the resistant individuals continue to reproduce. Eventually, the whole population is made up of individuals with resistance to the pesticide. Pesticide resistance has been found in insects, mites, weeds and rodent populations.

The best way to prevent the development of pesticide resistance is to use non-pesticidal methods whenever possible. This also ensures that when pesticides must be used, they will still be effective.

### **Pesticide Risks to Humans and Nontarget Organisms**

Many common pesticides are broad-spectrum poisons. If used improperly, they can harm or even kill people and other non-target organisms, such as pets, plants, beneficial insects, wildlife, birds and fish. Generally, broadcast applications of residual pesticides pose the most risk.

Many people are concerned about possible long-term effects of pesticides on their health. Some people are sensitive to certain pesticides, or to the carriers or other ingredients in the formulated products. They may have adverse reactions from exposure to very low levels of certain products. Also, there is increasing concern that some chemicals, including some pesticides, may disrupt hormone functions in humans and animals (these are known as endocrine disrupters). These concerns can be addressed by using alternatives to pesticides and least-toxic products wherever possible.

[• Top](#)

## **EVALUATION**

Evaluation is an essential part of every IPM program because it helps the pest manager:

- determine what worked and what didn't
- identify ways to improve the program
- assess the costs and benefits of the program
- identify changes to site design and management to prevent future problems

To evaluate an IPM program, the pest manager needs accurate records of treatments and results from:

- monitoring records of pest numbers and locations before treatment
- treatment specifics, including date, time, product names and rates used
- monitoring records of pest levels after treatment
- feedback from clients or site users

Accurate records of labour and other costs should also be kept so that the pest manager can set a fair price for IPM services.

[• Top](#)

## Conclusion

As described in this chapter, the basis of a landscape IPM program is prevention of pest problems, mainly through growing healthy plants. If controls become necessary, the IPM approach gives the pest manager a step-by-step process for managing pest problems. The emphasis on monitoring pest populations before making treatment decisions differs from the practice of applying pesticides based on a calendar schedule. Clients who are used to such scheduled pesticide applications may think that it is the only way to deal with a pest problem. The challenge to the landscape manager is to promote IPM to such clients so that they will accept the long-term, safer solution, instead of a short-term, 'chemical bullet'.

An increasing number of clients are demanding an IPM approach because they are concerned about pesticide use and environmental safety. Landscape companies who are used to selling the scheduled pesticide approach will need to upgrade their skills to serve such clients and adapt to changing markets and government regulations. Over the next few years, using IPM methods will become a condition for receiving a service license from the British Columbia Ministry of Environment, Lands and Parks (now called Ministry of Water, Land and Air Protection) to apply pesticides on public lands.

## Further Reading

\_\_\_\_\_. 1997. Plant Health Care for Woody Ornamentals: A Professional's Guide to Preventing and Managing Environmental Stresses and Pests. International Soc. Arboriculture and University of Illinois. 223 pp. (From: University of Illinois, ITCS, 1401 South Maryland Drive, Urbana, IL 61801. Tel: 800-345-6087 Web: <http://www.extension.uiuc.edu/pubs.html>)

Bobbitt, V., A. Antonelli, C. Foss, R. Davidson, R. Byther and R. Maleike. 1996. Pacific Northwest Landscape IPM Manual. Washington State University. 206 pp. (From: WSU, Cooper Publications Bldg., P.O. Box 645912, Pullman, WA 99164-5912. Tel: 1-800-723-1763 Web: <http://pubs.wsu.edu/cgi-bin/pubs/index.html>)

Daar, S., H. Olkowski & W. Olkowski. 1992. IPM Training Manual for Wholesale Nursery Growers. Bio-Integral Resource Center, Berkeley, CA. 80 pp. (From: BIRC, PO Box 7414, Berkeley, CA 94707. Tel: 510-524-2567 Web: <http://www.birc.org/>)

Dreistadt, S. H. 1994. Pests of Landscape Trees and Shrubs: An Integrated Pest Management Guide. Pub. # 3359. University of California. 327 pp. (From: ANR Publications, Univ. of Calif., 6701 San Pablo Ave., Oakland, CA 94608-1239. Tel: 800-994-8849 Web: <http://anrcatalog.ucdavis.edu/>)

Olkowski, W., S. Daar, & H. Olkowski. 1991. Common Sense Pest Control. Taunton Press, Newtown, CT. 715 pp. (From: Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707. Tel: 510-524-2567 Web: <http://www.birc.org/>)

## Study Questions

1. For each statement in Column A, choose the best match from Column B.

### Column A

- \_\_\_ Integrated Pest Management
- \_\_\_ preferred pesticides
- \_\_\_ sanitation
- \_\_\_ pest identification

### Column B

- a. using beneficial species to control pests
- b. a decision making approach
- c. the ideal starting place in managing pests
- d. least toxic products with low impact on non-target



- \_\_\_ biological control                      organisms
- \_\_\_ prevention                              e. first step in an IPM program for an existing pest problem
- \_\_\_ indicator plants                        f. first to show a problem
- g. pruning out branches with disease infections

2. What are four advantages of using IPM methods to manage pests?
3. At its most basic, what does prevention of pest problems mean in a landscape?
4. List and describe the five main steps in a IPM program for an existing pest problem.
5. In landscapes, what is the most likely cause of damage to plants?
  - a) insects
  - b) diseases
  - c) environmental conditions
6. Monitoring is used in an IPM program to do what?
7. What is a pheromone trap and what is it used for?
8. In landscape IPM programs, the injury level depends on what factors?
9. List five general types of controls used in landscape IPM programs.
10. Why is evaluation an essential part of an IPM program?

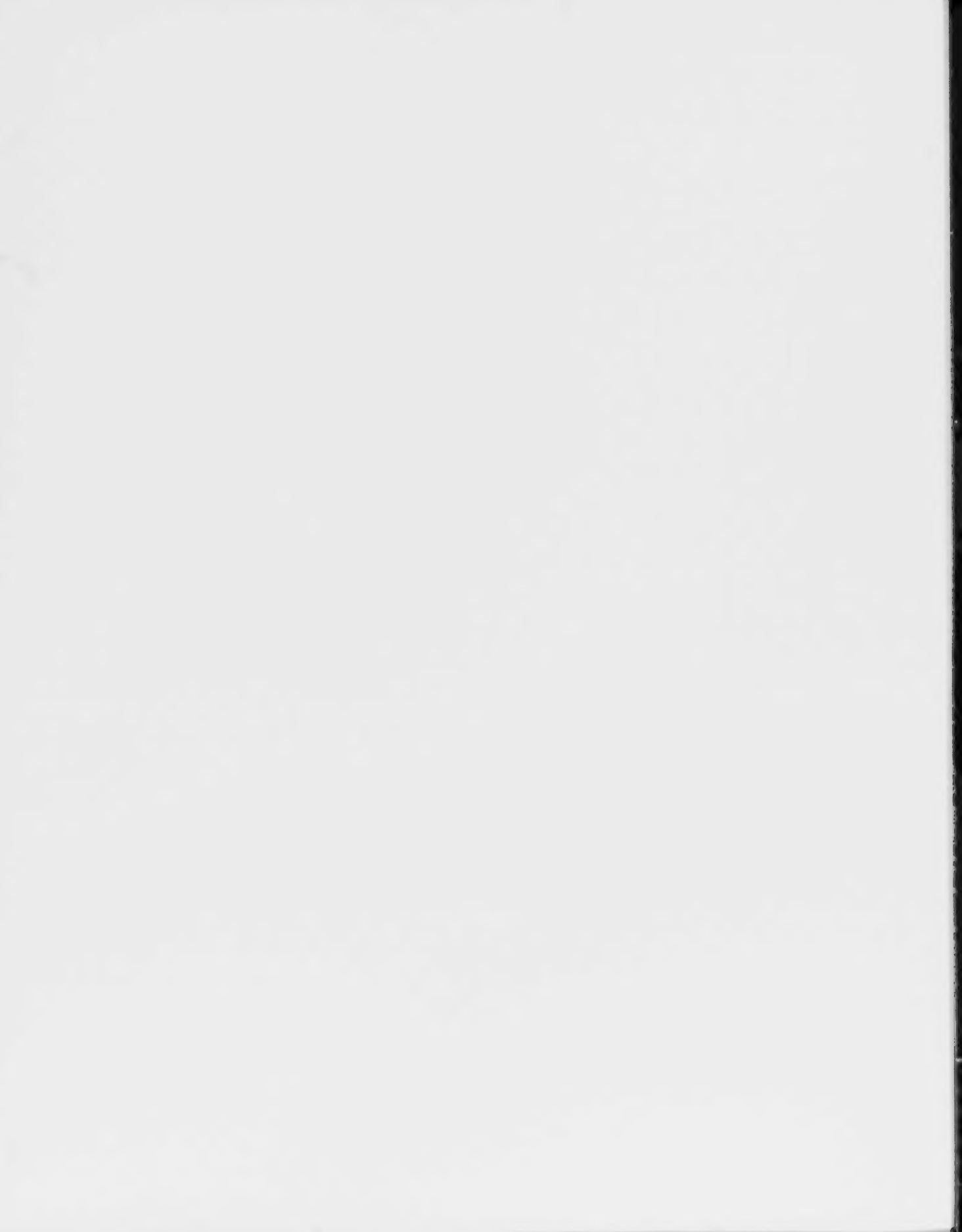
[Return to Table of Contents](#)

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.







## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

---

## Chapter 2 — Moving From Theory to Practice

---

### ***Learning Objectives***

When you have completed this lesson, you should be able to:

1. *Outline seven steps in developing an IPM program for a landscape.*
2. *Set practical objectives for an IPM program.*
3. *Describe the purpose of categorizing sites according to maintenance levels and describe a three-category classification system.*
4. *Describe five types of background site information useful in developing an IPM program.*
5. *Describe four types of information to record in a site assessment.*
6. *Describe how to analyze site assessment information and apply it to developing an IPM program tailored to the site.*

[Top](#)

---

### ***Introduction***

How do you get from a textbook description of IPM to applying the practices in your own work? The aim of this chapter is to bridge this gap by describing practical steps for developing an IPM program. Most of this information should be useful for anyone involved in managing landscape pests, whether they are new to the IPM approach or are looking for ways to improve an existing IPM program. Suggestions for managers of service companies or agency departments are also included in a section at the end of the chapter.

### ***Developing a Landscape IPM Program***

The following seven general steps include tips from landscape professionals who have worked out ways to apply IPM methods in their practice. Not all of these steps will apply in every case, of course, so use what makes the most sense in your situation.

## 1. Set Realistic Objectives

Trying to make a lot of changes at once is hard to do successfully and it is discouraging if things don't go well. So, start with manageable goals and well defined objectives. Write them down. For example, you could start by choosing to work on:

- one site, a small part of a large site or a limited number of smaller sites, or
- site(s) with the fewest pest problems (e.g., start with a landscape of only turf and trees rather than one with turf, trees, shrubs, perennial borders and display beds), or
- key pests or key plants (e.g., concentrate on managing weeds in turf, or aphids in boulevard trees)

Where to start depends on the types of plantings and pest problems being managed, as well as what type of agency or business is involved. For landscape services with residential clients, an excellent way to get started is to work with a few customers who are interested in IPM. To find these people, you can ask for volunteers (e.g., by personally talking to clients, by putting a note in with monthly account statements or in a company newsletter). A good time to involve clients is early in the season when they are beginning to make plans for their landscapes. You can learn a lot by working closely with these clients, keeping them informed and asking for their feedback as you go. As you gain experience, you will develop the skills and confidence to apply IPM to more accounts.

For landscape managers operating under the direction of a municipality, school board, or other agency, the following methods of categorizing sites may help in deciding where to start.

## 2. Categorize the Sites

A good way to set priorities for an IPM program is to divide landscape sites (or parts of large sites) into categories according to the level of maintenance they require. This makes it easier to see where to concentrate efforts and helps with decisions about managing pests. Injury levels, for example, will vary with the purpose and visibility of the site. The amount of money and time worth spending on treatments also varies with the type of site. High profile sites usually need the most resources for monitoring and pest management. In contrast, there may be no need to monitor or manage pests in some low profile sites.

A simple system recommended by BC Environment, and used widely in municipal landscapes, divides sites into three categories. These are:

- Class A — High level of service: These are high value, high visibility or high maintenance sites, such as formal display beds in parks or residential yards, fine lawns, golf and bowling greens, hanging baskets, botanical gardens, plant nurseries and conservatories.
- Class B — Moderate level of service: These are medium visibility or moderate maintenance sites, such as boulevards and medians, general park and playground areas, residential backyards and perennial borders in parks.
- Class C — Low level of service: These include low profile or low maintenance sites, such as nature parks and recreational areas, picnic areas, hiking trails, works yards and industrial sites.

This classification system is used throughout this manual in the chapters on managing specific types of pest and sites. Other ways to classify sites could be used, including the six landscape maintenance levels described in detail in the British Columbia Landscape Standard (see Further Reading at the end of this chapter) if they are more suited to your situation.

[Top](#)

### 3. Assemble Background Site Information

The more background information you have about a landscape, the better your IPM plan will be. Background information on a site includes historical information, expected pest problems, treatments available, resources available and regulatory requirements that may apply.

a) Collect historical information, including:

- notes, observations and other written records of weather, site conditions, pest problems, plantings, fertilizing schedules, etc.
- spray records and other treatment records from previous years
- account records that might show what work was done
- knowledge staff may have in their heads, but haven't written down (hold an informal brainstorming session to get this information down on paper)

Ideally, this information is available and only needs to be organized in reality, however, records may be scarce. For newly established sites, records will not exist; in this case, past experience with similar landscapes in the region could be used as a guide. Extension publications on pests of the region are also useful references for what to expect. For new clients, arranging a meeting to discuss problem areas in the landscape may provide helpful background information.

b) Find out about pests likely to be problems and collect information on:

- life cycles and biology
- range of host plants that may be affected
- conditions that favour the pests
- conditions that prevent pest development
- natural enemies of the pests

*Note:* Suggested references are included under Further Reading at the end of each chapter.

c) Research the range of treatments available, including:

- which pests they are effective against, and, in the case of pesticides, which pests and locations of use they are registered for
- mode of action and how well they are expected to work
- factors that would limit use to specific times or places, such as temperature, relative humidity, moisture conditions, life stage of the pest affected, toxicity
- cost and availability from suppliers

d) Make an inventory of the resources available for the IPM program, including:

- financial budget, for labour, supplies, travel, new tools, capital items and training
- people, in terms of time available and their skills, interests and qualifications
- supplies, tools and equipment on hand

e) Research regulatory requirements and guidelines that apply, including:

- provincial regulations regarding pesticide use. These are spelled out in the *Pesticide Control Act* and Regulation. See the Handbook for Pesticide Applicators and Dispensers for information on all legislation in British Columbia relating to pesticide use, handling and disposal
- municipal bylaws, which may specify pesticides that may or may not be used, or require

posting or notification of pesticide applications. Water use restrictions may also be in place, which will affect management plans for landscapes

- local school board, hospital board or other agency policies on pesticide use or pest management methods that may be used

#### 4. Conduct a Site Assessment

A site assessment is a systematic inspection to collect current, site-specific information. Much of this information will be easy to read and analyze if it is entered on a map, therefore, making a scale map of each site is highly recommended. Producing site maps involves some extra work at the beginning, but it is a tool that will be useful for many years. The site map can be as simple as a hand drawn sketch kept in a binder—or as sophisticated as a computerized map with links to electronic files about the site. Software packages for mapping and designing landscapes are available from software dealers.

The types of information to record in making a site assessment include:

##### a) Physical characteristics:

- Record soil conditions, such as type (sandy, loamy, clay), depth and drainage; take soil tests to determine pH, fertility, organic matter content, cation exchange capacity (a measure of nutrient availability).
- Describe micro-climate conditions. Within the overall climate of a region there are micro-climates of temperature, exposure to sun, wind, shade, frost patterns and air circulation that can make a large difference to the health of plants.

##### b) Plant inventory:

- Identify the species of plants in the landscape and also the cultivars, if possible, as cultivars can vary widely in growth habit, management and susceptibility to pests.
- Record the locations and plant names on the site map.
- Inspect each plant and note whether it is healthy, has pest problems, shows signs of nutrient deficiency, has growth abnormalities or needs pruning. Since the basis of an IPM program is prevention by growing healthy plants, this assessment of plant health is essential information.

##### c) Use patterns:

- Note who uses the site and for what purpose. This will be useful in developing injury levels and selecting the most suitable treatments.

A large municipal park usually contains several areas with differing purposes and users—from picnic areas to playing fields to display gardens. Even within small, residential landscapes there may also be differences in use and purpose. For example, appearance may be most important in the front yard, whereas, safety for children at play might be most important in the backyard. In an IPM program, these differences would translate into differences in treatment thresholds and treatments.



##### d) Environmental concerns:

No landscape exists in isolation from the rest of the environment. How a landscape is managed can affect much more than the immediate users. In the site assessment, look for conditions that should be taken into consideration, such as:

- potential for runoff that might erode soil or carry pesticides and fertilizers into water bodies, ditches or storm drains
- use by wildlife, such as birds, mammals, butterflies, and others
- impact on neighbouring properties, as a result of changes to the landscape design or the type of treatments used

This information is also useful in setting treatment thresholds and choosing treatments.

• [Top](#)

## 5. Analyze the Site Assessment Information

There are several places to start analyzing this information. Areas of little concern will likely be obvious, as will plants or areas that are especially important. The following are some ideas of things to look for that will help in drafting an IPM program:

- Identify key plants in the landscape. These are plants that play more important roles than others in the appearance, design or use of the landscape. For example, turfgrass is obviously a key plant in a park with a playing field; other examples might be specimen plants in a residential yard, ground cover plants stabilizing a steep bank or trees along a boulevard.
- Look for opportunities to replace problem plants. Notes on plant health and past history of pests may highlight plants that could be replaced (or moved to more suitable conditions), either now or in the future. For example, if only one or two plants in a border have problems, perhaps they can be replaced with trouble-free plants.



*Compacted and bare turf*

- Look for opportunities to make changes to the site design or facilities that would reduce long-term cost of managing pests. For example, where people continually wear a path through a section of turf, it leaves bare patches open to invasion by weeds. This could be addressed by installing a permanent barrier to stop the foot traffic or by laying a pathway with a durable surface.
- Identify pest problems (i.e., broadleaf weeds or red thread disease in turf) that can be managed by improving the cultural conditions.

- Pick out sites where user patterns, environmental concerns or other factors would rule out the use of certain types of treatments. For example, herbicides would be ruled out where there is a high risk of chemicals moving off-site into a stream. Using flammables to control weeds would be ruled out in a high fire hazard area.
- Pick out sites well suited to particular treatments. For example, greenhouses and interior plantscapes are well suited to the use of biological control agents. Containerized rhododendrons and irrigated display beds are ideal places to use insect parasitic nematodes to control root weevils.

## 6. Draft a Site Specific IPM Program

General IPM programs for the most common types of sites and pest problems in BC landscapes are



outlined in Chapters 4 to 10 of this manual (other useful references are listed at the end of the chapter). Using these as a guide, along with the background information and site assessment information, work through the steps of an IPM program described in Chapter 1. Look at this as a flexible, working plan, which will be changed and improved over time.

Here are some suggestions from IPM professionals to help you get started.

### **Identification**

- Establish a policy that ensures every pest or plant injury problem is recorded and that no treatment action is taken until the problem has been identified.
- Start an identification collection and continue to add specimens over time. This might include a photograph collection as well as actual specimens of insects and pressed weeds. If possible, keep duplicate specimens or a photographs of any samples you send to professional identification services; that way you have your own correctly identified specimen for your collection.
- Start a reference library that can be used to look up information about pests, plant health care, treatments and controls. Collect reference books, journals, pamphlets; set up information binders or files of reprints, magazine articles and other notes.

### **Monitoring**

- With a knowledge of the expected pests on the site and the key plants, draft a monitoring program for pests on those plants, taking into account the time of year that the pest problem is expected.
- Choose a monitoring method and draw up a record sheet so that it is easy for the person doing the monitoring to record results (see Appendix II for examples). While all the basic information should be recorded, don't make the record sheet too complicated — if it is hard to use, mistakes will be made or the information may not be entered at all.
- Set up a filing or record management system so that information on each site is easy to find and use. This would include site maps, monitoring records, injury thresholds and treatment information for each site.

*Note:* A table of insect monitoring methods and timetables is included in the current Nursery & Landscape Pest Management and Production Guide (see Further Reading at the end of this chapter).

### **Action Decisions**

Taking into account the objectives, users, and category of each site, set injury levels or thresholds for the pest population. To start with, these may simply be a best guess, based on experience or on information in publications (for suggestions, see each section on Action Decisions in Chapters 4 to 10). You may also carry out practical research of your own to work out injury levels, such as for acceptable percentage of weed cover in turf (described in Chapter 5). The injury levels should be revisited regularly (usually annually) to fine-tune them in light of experience. When treatments are decided upon, use information about how the treatment works to decide when it will be used and set action levels (treatment thresholds).

### **Treatments**

- Establish a policy on preferred treatments — what will be used and in which cases — and make sure everyone involved is aware of it. For example, list acceptable pesticides and methods of application and post the list where it is easy to see



- If you do not have the preferred products in stock, make sure you know where to get them and pre-order, if necessary. This means you can act immediately if monitoring shows that action levels for treatment have been reached. It also makes sure that the intended product will be used, rather than something else that happens to be on hand. For biological controls, contact suppliers well beforehand, to find out about availability, recommendations on use and shipping arrangements.
- Order special tools, such as pheromone traps or head-band magnifying lenses; locate and buy equipment, such as flamers or infra-red weeders, special pesticide applicators, bait stations.
- Establish a schedule for evaluating the effects of treatments.
- After the busy season is over, schedule an IPM review to evaluate the results of your efforts and plan for next year's improvements. Include monitoring records, financial accounts and feedback from staff as well as clients or site users.

## 7. Revise the IPM Program

Revisit your objectives and, as you gain experience and confidence, widen the scope of your IPM program to include more sites, other pests and additional techniques. With each year of experience you will be able to:

- improve monitoring methods and record sheets
- refine injury and action thresholds
- identify equipment you need to modify or purchase
- determine and act on staff training needs

• Top

## Manage For Success

To organize successful IPM program in a company or agency with a number of employees, it is important to manage people so that they have the time, skills and resources to do the job well. Suggestions for managers include:

- Make a commitment to the IPM project by making sure someone is specifically in charge of seeing that planned IPM work gets done.
- Involve all staff so that they know who has what responsibilities, where to find information, etc. Keeping everyone informed, including "front office" staff, helps them in their dealing with clients and the public.



*Learning to monitor*

- Allow enough time for staff to do the monitoring and keep records, perhaps by setting aside specific time for monitoring. Monitoring may not get done if staff are expected to add it onto other work without allowing for extra time to do it. Allow for the fact that monitoring usually takes longer at first. It will take less time as people become more skilled and the monitoring program is refined with experience.
- Make sure that staff are trained and know how to perform the work, whether it is monitoring, keeping records or using new treatment methods.
- Invest in reference materials, subscriptions to IPM publications and professional publications for use by staff (suggested basic references are listed under Further Reading at the end of each chapter of this manual).

[• Top](#)

## **Educate and Communicate**

An essential part of putting it all together is communication. Although good communication between staff and with clients or site users is always desirable, it is particularly important when making changes to the way you do things. Although IPM methods are well established among landscape professionals in BC, it can still feel risky to someone trying to adopt IPM methods for the first time. So get to know other landscape professionals and learn from them. Involve your staff or your co-workers in the whole project and take advantage of their interest and enthusiasm to make it work. Let your clients or site users know what you are trying to do.

Above all, don't forget to promote your success! Whether it is through a newsletter to your clients or a public brochure for municipal park users, let people know about your IPM practices. As a result of such promotion, companies often receive favorable coverage in the local press —a great way to boost business.

## **Further Reading**

\_\_\_\_\_. 1998. Nursery and Landscape Pest Management and Production Guide. BC Ministry of Agriculture & Food and BC Landscape & Nursery Assoc. (From: BCLNA, #101-5830 176A St., Surrey, BC V3S 4E3. Tel: 604-574-7772)

\_\_\_\_\_. 1997. British Columbia Landscape Standard. BC Society of Landscape Architects and BC Landscape & Nursery Assoc. 108 pp. (From: BCLNA, #101-5830 176A St., Surrey, BC V3S 4E3. Tel: 604-574-7772)

### **Study Questions**

1. What could be a realistic objective to choose for a beginning IPM program? Give 3 examples.
2. Why is categorizing sites according to levels of maintenance a useful practice?
3. What information should you collect about pests likely to be problems? Give 3 examples.
4. a) What general types of information should be recorded during a site assessment?  
b) How will this information be useful?
5. Why should you plan to review injury levels regularly?

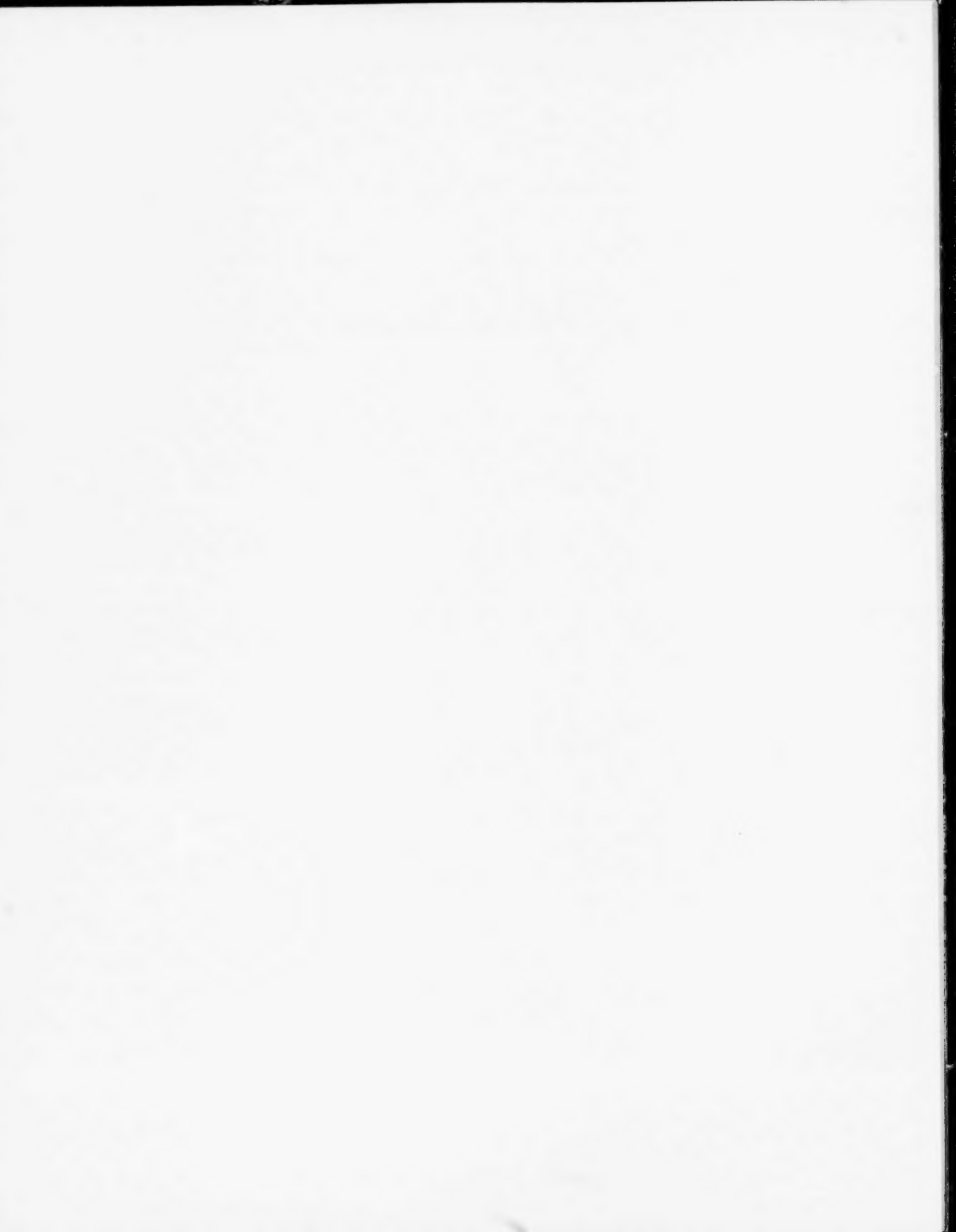
[Return to Table of Contents](#)

[• Top](#) [• Copyright](#) [• Disclaimer](#) [• Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.





• Ministry Home

• Government of British Columbia

**Environmental Management Branch**Ministry of  
Water, Land and  
Air Protection[The Minister](#)[News](#)[Search](#)[Reports & Publications](#)[Contacts](#)

## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

#### Chapter 3 — Preferred Pest Controls

##### *Learning Objectives*

When you have completed this lesson, you should be able to:

1. Describe the use of heat treatments and mulches to control vegetation.
2. Describe the use of sticky tree bands to trap winter moths.
3. List three groups of biological control agents used in outdoor landscapes and describe their target pests and uses.
4. State four characteristics of preferred pesticides.
5. Describe the mode of action and uses of the preferred pesticides: [*Bacillus thuringiensis*], boric acid, horticultural oils, insecticidal soap, pyrethrins, kinoprene, tebufenozide, fatty acid herbicide, [*Agrobacterium radiobacter*], sulfur, lime sulfur and ferric phosphate molluscicide

##### *Introduction*

Treatments that suppress pests, while presenting the least risk to applicators and site users and doing the least harm to the environment, are preferable to those that have more toxic or broad-spectrum effects. Mechanical, physical and biological control agents (natural enemies) usually fit this description, as do some registered pesticides. This chapter describes:

- selected physical and mechanical controls used in BC,
- commercial biological control agents useful in landscapes, and
- preferred pesticides for use in landscape IPM programs.

[• Top](#)

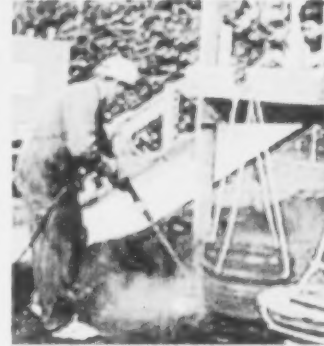
##### *Mechanical and Physical Controls*

There are many different mechanical and physical controls that may be used in landscapes. Examples of these are listed in the specific pest management chapters of this manual (see Chapters 4-10). Three mechanical and physical controls are described in greater detail below because they are of particular interest to pest managers in BC.

### Heat Treatment for Vegetation Control

Various systems have been invented to deliver high temperatures to kill the foliage of plants. They include:

- Flamers, which have been in use for over 50 years. Several sizes of hand-held propane torches are available, as well as tractor mounted flamers. Flamers produce temperatures of about 900°C.
- Hot water or low-pressure steam applicators, which have become more widely available since the early 1990's. Most are large pieces of equipment, mounted on trucks or trailers, however, development of smaller and hand-held models continues. These deliver 100-200°C water or steam to plant surfaces.
- Infrared radiation applicators, which burn propane fuel to produce a radiant heat source. Equipment now available ranges from hand-held applicators for spot treatments of dandelions to hand-propelled and tractor mounted units for broader treatments.



*Hot water applicator*

Various models of the heat applicators described above are sold or leased by suppliers. Some service companies purchase the equipment and provide treatments on a contract basis. Much of this equipment is large and more suited to municipal or industrial use, however, hand-held flamers are widely available. Small infra-red applicators have recently become available in Canada.

*Mode of Action:* High temperatures tear apart plant cells and destroy proteins in the cells. It is only necessary to heat the leaf long enough to destroy the waxy cuticle of the leaf and disrupt the cells. Torching or boiling the plants until damage can be seen immediately is unnecessary and may stimulate re-growth of some established perennials such as morning glory. Effects of heating may be visible in as little as an hour or take up to several days to show.

Seedlings, annuals, young perennials and germinating seeds are most susceptible to heat damage. They are usually killed by a single treatment. None of the heat treatments penetrate into the soil or below a layer of gravel, therefore they do not kill the roots of established perennials. Perennials may require three or more treatments in a season to deplete the roots and kill the plant.

Broadleaf weeds are more easily damaged by heat than grasses are. The growing tips of grasses are encased in a heat resistant sheath, which makes it possible to selectively control weeds in turf using a flamer (but practice your technique in a low visibility area first!). Some other plants are quite susceptible to heat. For example, research in BC found that low-pressure steam killed Scotch broom with only one treatment. Use: Using heat to control vegetation is ideal where non-selective control is required, such as:

- hard surfaces where any plant growth is undesirable (i.e., graveled areas, cracks in sidewalks and pavements)
- where all vegetation must be kept very short (i.e., around fire hydrants, sign posts, utility poles, metal sprinkler heads and along fence lines)
- for marking lines on playing fields and ball diamonds, which can be done using a narrow applicator head

With the right size of nozzle or head, some heat applicators can also be used to control weeds selectively in flower and shrub beds.

Where flamers are used, the risk of causing a fire or damaging plastic fittings, such as sprinkler

heads, must be taken into account. When using the flamer, direct the hottest part of the flame (this is the cone-shaped area around the flame) at the weeds. Hold the nozzle above the plants and slowly pass it once over the plant.

Plants in dry conditions appear to be more susceptible to heat treatments than in cool and moist conditions. Weeds are most susceptible to heat when less than a few centimetres tall (the 4-5 leaf stage). This stage is when the roots are also killed by the heat treatment. In the cool, moist conditions of the coast, several treatments may be needed annually: one in spring to kill the majority of seedlings, followed by a treatment after fall rains cause another flush of germination. Regular treatment prevents establishment of perennials.

• [Top](#)

### **Mulches for Weed Control**

Mulches are soil coverings of organic materials (leaf mould, compost, straw, shredded bark, pine needles, wood chips, sawdust) or various synthetic materials, such as plastic sheeting or landscape fabrics (geotextiles). A common combination in ornamental planting beds is a geotextile weed mat covered with a layer of bark or gravel.

**Mode of Action:** Mulches suppress weeds by blocking the light they need to grow. As soon as seeds germinate, the tiny plants must reach light or they will die. Some weed seeds won't even germinate unless they are exposed to bright light.

Mulches have other uses in plant beds, including holding moisture in the soil and moderating soil temperatures. Organic materials also add nutrients to the soil as they decompose and they keep the soil surface from becoming compacted. This makes it easy to pull any weeds that do manage to grow through the mulch. Organic mulches must be periodically renewed as they decompose.

Synthetic landscape fabrics designed for use in planting beds allow water through, while preventing seeds below the mat from germinating. Some heavier geotextiles are also designed for use under gravel or bark pathways. These may need regular maintenance, however, as enough soil can be tracked onto the gravel to allow grasses and other seeds to grow on top of the mulch.

**Use:** Mulches are well suited to perennial flower and shrub beds, where they can stay undisturbed around permanent plantings for years. Ideally, geotextiles should be installed at the time the bed is first planted. After the soil is prepared and the fabric laid down, plants can be set into the soil through slits in the fabric. After planting, spread bark, gravel or other surface mulches over the fabric. Geotextiles can also be installed around previously established plants — it just takes more time to cut and fit the fabric.

To be effective at suppressing weeds, organic mulches should be at least 10 centimetres thick for heavy, dense materials and at least 16 centimeters deep for fluffier, lighter materials. Shredded bark or wood chips laid over geotextiles, however, need only be deep enough to give the desired appearance because the fabric is controlling the weeds.

Mulches should be applied as soon as the soil is cultivated or disturbed because weed seeds brought to the surface start to germinate immediately. This means you should have mulch materials on hand and ready to use when beds are being planted or weeded.

Using fresh sawdust, wood chips or straw as a mulch will temporarily rob the soil of nitrogen as the materials decompose. This means that where such mulches are used around growing plants, it is usually necessary to dig in extra nitrogen fertilizer before applying the mulch. The nitrogen robbing effect can be used to advantage, however, to starve weeds in pathways and other areas where plants are not wanted.



### Tree Bands for Winter Moth

In southern Lower Mainland, Vancouver Island and the Gulf Islands, the winter moth (*Operophtera brumata*) has been a problem for the last two decades. In the spring, the caterpillars eat the leaves, buds and flowers of apple, cherry, other ornamental and fruit trees and roses, as well as leaves of maple, oak, birch and elm. In Vancouver, experience has shown that Norway maple and some Japanese maple cultivars are particularly susceptible. Defoliation damage is a major source of complaints to parks departments in infested areas.

In the early 1980s a species of parasitic wasp and a parasitic fly were released by Agriculture Canada to provide biological control. Research has also discovered the important role native ground beetles play in preying on winter moth cocoons. In most years, these natural enemies largely keep winter moth numbers down on Vancouver Island. In Vancouver, however, and in other areas when moth numbers are high, additional controls are often necessary, particularly on boulevard trees.



Sticky tree bands

**Mode of Action:** Sticky tree bands work well as a physical control because of the winter moth's peculiar biology. The adult moths are active in the early winter, which is when they mate and lay eggs. The female moths, however, cannot fly (it is the male winter moths that you see flying into car headlights in December). The females must walk up the tree trunk to lay eggs out on the branches, therefore a band of sticky glue around the trunk can catch them before they lay eggs. The bands are only needed between mid-October and late January, which is ideal to avoid harming beneficial insects and spiders that travel up tree trunks at other times of the year.

#### Use:

1. Start by wrapping a 15-cm wide band of cotton batting around the trunk to fill the crevices in the bark. This is to keep moths from crawling under the sticky band. The cotton layer is most important where there are high numbers of moths and on trees with rough bark.
2. Next, wrap a 15 to 20-cm-wide band of plastic food wrap or plastic sheeting around the trunk; several strips of wide plastic parcel tape can be used instead, wound around the trunk to make the same width. Plants with multiple trunks must be banded on each trunk; it may be necessary to band the plants next to susceptible trees as well, to keep moths from using them as another route up to the leaves.
3. Where moth populations are low or moderate, one band is usually enough. Place the band at chest height or wherever it is convenient, depending on the shape of the trunk. Where moth populations are high, traps rapidly fill up with trapped moths. In this case, use two bands, 15-20 cm apart on the trunk (plan to replace the lower band when moths start to be caught on the top band).
4. Spread a 10-cm wide layer of insect glue (Tanglefoot®, Stikem®) over the band, making sure there are no gaps. The glue can be applied with a spatula, putty knife or stiff brush and spreads more easily when it is warm. Spread the layer of glue as thinly as possible over the upper two-thirds of the band. This leaves some space on the band to catch glue that could drip onto the trunk below in warm, sunny weather.
5. Put the bands up in mid-October. Periodically check that they are free of leaves and other

debris. Replace bands if they become full of trapped moths. Remove the bands and dispose of them in late January.

• [Top](#)

## **Biological Controls (Natural Enemies)**

Releasing commercially reared biological controls is a well-established method of controlling pests in greenhouses and interior plantscapes. There are over 20 species of beneficial insects and mites commonly sold for this use (see Table 1). Only a few species, however, have been shown to be practical for releases outdoors. Generally, the most useful approach outdoors is conserving and attracting native beneficial species (as described in Chapter 1).

The following section describes commercial biological controls that can be used in outdoor landscapes. Although microbial products are biological controls, they are also registered pesticides, therefore are discussed later in this chapter under Preferred Pesticides.

### **Insect Parasitic Nematodes**

Nematodes ("roundworms") are slender, tapering worms. There are thousands of species of nematodes: many attack plants, others break down organic matter, and there are beneficial species that attack insects. Although some nematodes are quite long ("horsehair worms"), most are microscopically small. Among them are the insect parasitic nematodes. To date, the nematodes available in commercial products have been species of *Steinernema* or *Heterorhabditis*, although others are under development.

**Target pests:** Various species of insect parasitic nematodes can be used to control the larvae of root weevils, crane flies (leatherjackets), fungus gnats and other turf and nursery pests. They have been used successfully in Toronto in tree bands to control elm leaf beetle larvae. Generally, *Steinernema carpocapsae* is better suited to webworms, cutworms, girdlers and wood-borers, while *S. feltiae* is more suited to fly larvae. *Heterorhabditis megidis* is now available for black vine weevil control. Other species particularly suited to control white grubs and other root weevils may become available in the future.

**Use:** Nematodes are sold in a dormant stage so that they survive storage and shipping. To apply them, the nematodes are mixed in water and applied to the soil. They can also be applied through irrigation systems. Since products differ, always follow application instructions with the product.

Nematodes are generally not effective in dry soil conditions. They are most useful in greenhouses, nurseries, and planting beds where regular irrigation keeps the soil moist. For outdoor use it is usually advisable to irrigate plantings well, both before and after the nematodes are applied, to soak them into the root zone. Nematodes are also not effective in cool conditions. Currently available species should be used when soil temperatures are above 12°C.

On potted plants, research has shown that overhead irrigation can wash the nematodes out of the soil within a month. Where changing to a sub-irrigation method for greenhouse benches is not feasible it may be necessary to apply nematodes more often to get good results.

• [Top](#)

### **Predatory Midges**

The aphid midge, *Aphidoletes aphidimyza*, is a hardy, native insect that is reared commercially for

use outdoors and indoors. Once released in an area they can become established for long-term control of aphids. They can be used along with the other species of native aphid predators that commonly attack aphids.

**Target pests:** Aphid midges feed on over 60 species of aphids, including all common species found in ornamentals and food crops. They are widely used in greenhouse vegetable production in BC and are also used in conservatories and interior plantscapes. They have been used successfully outdoors to control aphids in rose beds, boulevard trees and ornamental fruit trees.

**Use:** Aphid midges are sold in the pupal stage, usually in a carrier such as vermiculite. The carrier can be gently spread on the soil in the shade and kept moist until the adult midges have emerged. Alternatively, the containers can be held indoors until the first adults are seen, then opened and placed among the plants for a couple of days so the adults can fly out of the container.

The adult midges lay eggs among aphids on the trees and shrubs. The eggs hatch into tiny orange larvae, which feed on aphids for a week to 10 days. They drop to the soil to pupate and burrow several centimetres into the soil to spin cocoons. Adults emerge in 2-3 weeks. The last generation in late summer remains in the soil to overwinter.

Outdoors, *Aphidoletes* are usually released 1 to 3 times, 10-14 days apart, starting as soon as aphids are present on plants in the spring. They may also be released at the end of the summer if aphids are present on outdoor plants. This helps reduce the number of aphids that would lay eggs for overwintering. It also establishes an overwintering population of aphid midges that will be active early the next spring.

### Lady Beetles

Many different species of lady beetles are sold commercially to control soft-bodied insects and spider mites. Few, however, are useful outdoors (see Table 1 for species used in greenhouses). The convergent lady beetle, *Hippodamia convergens*, is the most widely sold, but its urge to fly away when released is a problem. The multicolored Asian lady beetle, *Harmonia axyridis*, is a better prospect (though not always available), because they do not have this instinct to fly away.

**Target pests:** Both lady beetles listed above are sold mainly to control aphids, although they will also feed on other small, soft-bodied insects.



Adult & larva lady beetle

**Use:** *Hippodamia* is usually not very useful in small areas outdoors unless it is prevented from flying away after release. The lady beetles are collected in California in the fall from large congregations of lady beetles that gather together to hibernate for the winter. When the beetles are released outdoors in the spring, their instinct is to fly away even though aphids are present. Some people claim success with keeping the lady beetles in the area by spritzing them with a clear soft drink when they arrive. The sweet liquid glues their wings together without harming them. This step may keep them around long enough to mate and lay eggs so that their offspring stay to control aphids.

Before buying lady beetles, however, consider that:

- there are many native lady beetle species already present in BC and these cost nothing to provide aphid control, and
- lady beetles (*Hippodamia*) are being scooped up out of their home range in large numbers to sell. This is not an ecologically sound practice and may not continue indefinitely.

• Top

## Predatory Mites

Several species of predatory mites are available from suppliers. Most are used commercially in greenhouse vegetable crops, however, the native species, *Amblyseius fallacis*, is also useful in landscapes in BC. This is because it is well adapted to the BC climate and can overwinter. Also, the commercially available strains are generally resistant to organophosphorous insecticides, although they are killed by synthetic pyrethroids. This means they can be released in landscapes and nurseries where some pesticide use is unavoidable.

Other species of predatory mites with limited application in landscapes are:

- *Phytoseiulus persimilis*: an effective predator for spider mites in warm, humid conditions, where no pesticides are used; it can be used outdoors in the summer in special situations, but is not hardy enough to overwinter in BC.
- *Amblyseius cucumeris*: used mainly to control flower and onion thrips in greenhouse vegetables; it also feeds on cyclamen and broad mites, spider mites and rust mites on outdoor plants.

**Target Pests:** Predatory mites are mainly released in landscapes to control two-spotted spider mite, European red mite and other spider mites in trees and shrubs. *A. fallacis* also feeds on rust mites and other mites found on trees and can overwinter to provide early season control of mites.

**Use:** Predator mites usually come mixed in vermiculite or on pieces of leaf. To distribute the mites, place the leaf pieces or sprinkle the vermiculite throughout the foliage of plants. Apply higher concentrations to areas with spider mite infestations. For specific release rates and instructions, contact the supplier for recommendations.

## Table 1. Biological Controls for Landscapes and Plantscapes

The following are examples of natural enemies sold commercially at the time of publication. This is a rapidly changing field, however, so always check with suppliers for product recommendations before ordering.

| For Outdoor Landscapes                              |                                                                                                              |
|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Pest Problem                                        | Beneficial Species                                                                                           |
| Aphids                                              | Aphid midge ( <i>Aphidoletes aphidimyza</i> )<br>Multicolored Asian lady beetle ( <i>Harmonia axyridis</i> ) |
| Spider mites                                        | Predatory mites ( <i>Amblyseius fallacis</i> & other species)                                                |
| Root weevil larvae                                  | Insect parasitic nematodes ( <i>Heterorhabditis megidis</i> )                                                |
| Crane fly larvae<br>(leatherjackets)                | Insect parasitic nematodes (( <i>Steinernema feltiae</i> )                                                   |
| For Indoor Plantscapes, Conservatories, Greenhouses |                                                                                                              |
| Aphids                                              | Aphid midge ( <i>Aphidoletes aphidimyza</i> )                                                                |

|                   |                                                                                                                                                                                                                                                                         |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   | Aphid parasitic wasps ( <i>Aphidius matricariae</i> and <i>A. colmani</i> )<br>Multicolored Asian lady beetle ( <i>Harmonia axyridis</i> )<br>Convergent lady beetle ( <i>Hippodamia convergens</i> )<br>Lacewings ( <i>Chrysoperla carnea</i> , <i>C. rufilabris</i> ) |
| Caterpillars      | Parasitic wasps ( <i>Cotesia marginiventris</i> , <i>Trichogramma</i> spp.)                                                                                                                                                                                             |
| Spider mites      | Predatory mites ( <i>Amblyseius fallacis</i> , <i>Phytoseiulus persimilis</i> and other species)                                                                                                                                                                        |
| Whiteflies        | Greenhouse whitefly parasite ( <i>Encarsia formosa</i> )<br>Lady beetle ( <i>Delphastus catalinae</i> )                                                                                                                                                                 |
| Mealybugs         | Australian lady beetle ( <i>Cryptolaemus montrouzieri</i> )<br>Parasitic wasp ( <i>Leptomastix dactylopii</i> )                                                                                                                                                         |
| Scale, soft brown | Lady beetles [ <i>Rhyzobius</i> (= <i>Lindorus</i> ) <i>lophanthae</i> , <i>Chilocorus nigritus</i> ]<br>Parasitic wasp ( <i>Metaphycus helvolus</i> )                                                                                                                  |
| Thrips, Onion     | Predatory mites ( <i>Amblyseius cucumeris</i> )                                                                                                                                                                                                                         |
| Western flower    | Minute pirate bugs ( <i>Orius</i> spp.)                                                                                                                                                                                                                                 |
| Fungus gnats      | Soil mite ( <i>Hypoaspis miles</i> )<br>Insect parasitic nematodes ( <i>Steinernema feltiae</i> )                                                                                                                                                                       |

• Top

## Preferred Pesticides

When it is necessary to use a pesticide, the first choice, ideally, should be a product that is least hazardous to people and the environment. In this manual, these are referred to as "preferred pesticides". They have one or more of the following characteristics:

- present the least short- and long-term health risk to humans
- have low impacts on non-target organisms (usually because of short residual effects)
- are most specific to the target species
- present the least risk to the environment during handling and disposal

Preferred products include microbial insecticides, which contain microorganisms that only attack certain insects, and insect growth regulators (IGRs), which disrupt insect hormone systems. Fatty acids, insecticidal soaps and horticultural oils are preferred because they only kill on contact and have no residual effects that would continue to affect non-target organisms. Botanical pesticides, such as pyrethrins, which are moderately toxic, are preferred because they have short activity periods, which minimizes their environmental impact.

The following section describes the characteristics and use of twelve currently registered preferred pesticides. Other pesticides registered for use on ornamentals should be considered only where preferred products or other types of treatments are not suitable or available. More information on using these products can be found in the *Handbook for Pesticide Applicators and Dispensers* and the current *Nursery and Landscape Pest Management and Production Guide* (see Further Reading at the end of this chapter).

• Top

## INSECTICIDES

### *Bacillus thuringiensis* (BT)

BT is a microbial insecticide containing the naturally occurring bacteria, *Bacillus thuringiensis*. Hundreds of strains of BT are known to researchers — of these, the BT *kurstaki* strain (BTK) has been registered for use on caterpillars since the 1960s; the BT *israelensis* strain (BTI) is used to control mosquito and fungus gnat larvae. The most recently registered strain, BT *tenebrionis*, (BTT) controls larvae of some beetles.

**Mode of Action:** In general, BT produces spores and protein crystals that infect and kill insects. BTK grows in the alkaline gut conditions of caterpillars. This causes them to stop feeding almost immediately (within 2-4 hours), even though it can take another 1-3 days for the caterpillars to die. The bacteria are not toxic to other insects, animals and people. Residual effects are short, as the bacteria survive only a few days in the environment.

**Formulation:** BT products are sold as liquid concentrates or wettable powders. BTI is also available in a granular form that can be spread in water where mosquitoes breed.

**Use:** BTK is used to control a variety of leaf-eating caterpillars on ornamentals and food plants, both outdoors and in greenhouses. These include: cabbage loopers, cankerworms, cutworms, diamond back moth larvae, apple ermine moth, Bruce spanworm, imported cabbageworms, leafrollers, spruce budworms and tent caterpillars. BTK is usually most effective on younger or smaller stages of caterpillars.

BTI is used to control mosquito larvae in ponds. To apply BTI products to water bodies an applicator must be authorized by the Ministry of Environment, Lands and Parks under a pest management plan or permit. The only exception is for ponds (usually artificial) that are entirely enclosed on private property with no outlet to a ditch or stream. BTI is also registered for control of fungus gnat larvae in commercial greenhouse flower production.



Caterpillar

BTT is currently registered for control of Colorado potato beetles on food plants; it has been used experimentally to control elm leaf beetle larvae.

Since the target larvae must eat BT to be affected, it must be applied while they are actively feeding. It shouldn't be used if rain is expected within the next 24 hours as the spores can be washed off the leaves before larvae have a chance to eat them.

BT is non-toxic to mammals and birds because the bacteria do not grow in warm-blooded creatures; the bacteria also do not harm fish, bees, beneficial insects, earthworms and other organisms.

• [Top](#)

### Boric Acid

Boron is an inorganic chemical element. Borax, which contains boron, is mined from deposits in the earth. Boric acid and other boron-containing compounds (called borates) are manufactured from borax.

**Mode of Action:** Boric acid acts as a stomach poison. It is particularly useful in ant traps and other insect baits.



*Formulation:* Boric acid is available in dusts, baits and ready-to-use liquids.

*Use:* The main use of boric acid is for structural pests. In landscapes and conservatories, it is mostly used to control ants, particularly where ants are hampering biological control of aphids by protecting the aphid colonies from predators. Place boric acid baits along ant trails, but out of reach of children or pets. Do not apply boric acid around growing plants, trees or shrubs as it has a herbicidal effect and may kill plants or retard their growth.

Boric acid remains effective as long as it is present. The toxicity is low to people and animals.



*Dormant apple tree*

### **Horticultural (Supreme) Oils: Dormant and Summer Oils**

Mineral oils, emulsified in water, have been used on dormant fruit trees for over 200 years to control overwintering pests. Modern horticultural oils are highly refined and some products can be used during the growing season as well as while plants are dormant.

*Mode of Action:* Oils acts upon contact, by suffocation and by disrupting other physical processes. They are broad-spectrum insecticides and miticides, with no residual effect.

*Formulation:* Oils are sold as liquid concentrates to be mixed in water to form an emulsion.

*Use:* As a dormant spray, oils are used to control overwintering eggs of aphids and some moths, also mealybugs, pear and rose slugs, scales and spider mites. Dormant oils are used only after the leaves of deciduous trees and shrubs drop in the fall or before growth starts in the spring. They should not be applied when freezing weather is predicted or while foliage is wet. The spray should have time to dry before rainfall or heavy dew forms.

Dormant oils are often mixed with lime sulfur for the control of insects, mites and fungal diseases (see Sulfur, below).

As a growing season spray, horticultural oils are used to control mealybugs, rust mites, scales, spider mites and whiteflies. With some exceptions, summer oils can be used on evergreens, woody ornamentals, roses, fruit trees and bushes and shade trees. Oils are phytotoxic to some plants, such as apricots, blue spruce, maples, and ferns, therefore always check labels for a list of plants that cannot tolerate oil sprays.

Use oils only on healthy plants, not suffering from disease, heat or drought stress. Summer oils should not be used in hot weather (over 30°C), under dry conditions or when temperatures below freezing are expected within a few weeks. Horticultural oils have low toxicity for mammals, birds, fish and other wildlife.

Summer oils reduce the populations of beneficial insects and mites that are contacted by the spray.

[• Top](#)

### **Insecticidal Soap**

Soaps to control insects are made from bio-degradable salts of fatty acids, similar to those in



household soaps.

**Mode of Action:** Soaps acts upon contact on most insects and mites and their eggs, providing broad-spectrum control, but without residual effects.

**Formulation:** Soap products are sold as ready-to-use products and liquid concentrates. Some products contain insecticidal soaps mixed with an insecticide, usually pyrethrins.

**Use:** Soaps are most effective on soft-bodied plant pests, such as aphids, mealybugs, pear and roseslugs, psyllids, scales, spider mites, whiteflies and other insects. Soaps are registered for uses indoors and outdoors on food and ornamental plants. Because soap works only on contact, it is important to spray all plant surfaces thoroughly. Repeat applications may be necessary, but it is a good idea to limit the number of times soap sprays are applied to the same leaves. This is because soaps can damage leaves of some plants. Soaps are particularly phytotoxic to bleeding heart, crown of thorns, gardenia, horse chestnut, Japanese maple, maidenhair fern, mountain ash, poinsettias and sweet peas (always check label for plants that cannot tolerate soap sprays).

Soaps are not toxic to fish, birds and other wildlife, but will kill beneficial insects that are contacted by the spray.

### Botanical Insecticides

Botanicals are pesticides made from active compounds found in certain plants. An advantage of botanicals is that they generally last a short time in the environment. Preferred botanicals include pyrethrins (from pyrethrum daisies) and azadiractins (from the neem tree). The latter is not yet registered in Canada, but products containing azadiractins and other active botanical compounds may be available in the future. Rotenone is a registered botanical, but it is so toxic when it is first applied that it is not recommended as a preferred pesticide.

Recent research in the US and Canada to find other naturally occurring active compounds in plants has come up with many promising plant compounds. Some have insecticidal and miticidal activity, others even have herbicidal activity. These are compounds found in common plants such as mint, thyme, cloves, soybean, peanuts, and Artemisias. Pesticides containing some of these ingredients are now available in the US and some may become available in Canada in future.

[Top](#)

### Pyrethrins

Pyrethrins are the active ingredients extracted from the pyrethrum daisy (*Chrysanthemum cinerariaefolium*).

**Mode of Action:** Pyrethrins are nerve poisons that provide broad-spectrum control of crawling and flying insects, without residual effects. Pyrethrins act upon contact, causing quick paralysis in insects. They are known for their quick 'knockdown' effect and irritant effect that drives insects, such as thrips, out of hiding places.

**Formulation:** Pyrethrins are sold as ready-to-use liquids, liquid concentrates, and dusts; they are also formulated in mixtures with other insecticides and fungicides.



Daisy

Many insects can detoxify pyrethrins and recover from exposure, therefore a synergist is often added to the formulation to help the pyrethrins work. Piperonyl butoxide, a common synergist, is derived from sesame. It works by inhibiting the activity of enzymes in the insect that normally detoxify pesticides.

*Use:* Pyrethrins are used to control aphids, caterpillars, flea beetles, leafhoppers, beetles, thrips, spider mites, stinkbugs, whiteflies, boxelder bugs, etc., on ornamentals and food plants. They are also used to control structural and nuisance pests, such as ants, earwigs, flies, mosquitoes, gnats and yellowjackets.

Pyrethrins are best applied in the evening or on a cloudy day; they should not be applied in direct sunlight or at temperatures over 32°C. Pyrethrins are generally not phytotoxic, however, there are a few exceptions, such as maidenhair fern and delicate seedlings.

Pyrethrum and pyrethrins are moderately toxic to mammals and birds, but are highly toxic to fish and will kill any beneficial insects contacted by the spray. Avoid inhalation and contact with skin and eyes; skin contact or inhalation may cause allergic reactions in sensitive people.

### Terminology

**Pyrethrum** refers to the dried, powdered, flower heads of the pyrethrum daisy.

**Pyrethrins** are the group of active ingredients found in the flowers. They are unstable when exposed to sunlight and last for only a few hours.

**Pyrethroids** are synthetic compounds made to resemble pyrethrins in chemical structure. They are more toxic to insects and more stable in sunlight than pyrethrins; they last for a week or longer in the environment.

• Top

### Azadiractin (Neem)

Azadiractin is extracted from seeds of the neem tree (*Azadirachta indica*). The extract contains several active compounds that affect insects by repelling them, inhibiting feeding and by disrupting their development. It has very low toxicity to mammals and degrades rapidly in the environment. It is registered for use on ornamentals and food crops in the US, but not in Canada at this time.

### Insect Growth Regulators (Juvenile Hormones, Chitin Inhibitors)

Insect growth regulators (IGRs) are insect hormones, or their synthetic mimics. The growth and moulting processes of insects are controlled by hormones. When insects are exposed to these hormones at critical times during their life cycle it interferes with their normal development. Two IGRs, kinoprene and tebufenozide, are currently available for use on ornamentals, with more IGRs expected to be registered in future.

### Kinoprene

*Mode of Action:* Kinoprene acts by disrupting normal development of eggs and immature insects and also by sterilizing insects. At higher application rates it kills adult insects. Effects on insect

populations are usually gradual, rather than immediate.

*Formulation:* Kinoprene (Enstar® is the only product registered at this time) is available as an emulsifiable concentrate to be mixed in water.

*Use:* Kinoprene is registered for use on aphids and whiteflies on ornamental plants in greenhouses (i.e., azalea, chrysanthemum, dianthus, fuchsia, geranium, hydrangea, marigold, pelargonium, petunia, snapdragon). As it may cause damage to blooms, it is best applied in the pre-bloom stage. Kinoprene sprays can damage some varieties of poinsettias and roses, therefore test spraying a few plants to check for damage is recommended before treating all plants.

• Top

## **Tebufenozide**

*Mode of Action:* Tebufenozide mimics the action of insect moulting hormones, causing larvae to stop feeding within hours of eating sprayed leaves. It may take 3-10 days for larvae to die.

*Formulation:* Tebufenozide (Confirm® is the only product registered at this time) is available as a liquid concentrate to be mixed in water.

*Use:* Tebufenozide is used to control larvae of moths, such as codling moth, leafrollers, winter moth and other caterpillars on ornamentals and food crops.

It is non-toxic to bees and does not affect predatory mites, wasps and other beneficial insects.

## **HERBICIDES**

### **Fatty Acids**

Naturally occurring fatty acid compounds are used in production of soaps. In the right concentration they will kill the foliage of plants.

*Mode of Action:* Fatty acids kill the foliage of most plants upon contact. They act quickly, with results showing up within 2 hours. They do not kill the roots of established plants. There is no herbicidal activity in the soil and no residual effect.

*Formulation:* Fatty acid herbicides are sold in liquid concentrates and as ready-to-use sprays.

*Use:* Apply in spring or summer to actively growing weeds, less than 13 cm tall. Fatty acids are most effective on seedlings and annual plants, such as redroot pigweed, lamb's-quarters, corn spurry, mustards, chickweed and others. They also suppress or top-kill some perennials, including plantain. Repeat applications are required to kill established plants and perennials.

Products are registered for use outdoors around shade trees, nurseries, parks, sidewalks, driveways, mulch, fence posts, greenhouses and before planting grasses, ornamentals and vegetables.

Do not apply if rainfall is expected within two hours and avoid spray drift on desirable plants. Do not plant in treated soil for 3 days after treatment.

Fatty acids have very low toxicity to mammals and low toxicity to fish and other wildlife.

• Top

### Corn Gluten Meal

A new, non-toxic herbicide made of extracts from food-grade corn gluten meal has been registered in the US. It works by suppressing the germination of weed seeds. Regular use on turfgrass has shown a 50-60% drop in weed infestation in the first year, with higher levels of control in later years. It is not currently registered in Canada, but may become available in future.

### Dandelion Mycoherbicide

Researchers at McGill University in Montreal have discovered a strain of the fungus *Sclerotinia minor* that kills dandelions and other broadleaf weeds in turf without harming turf grasses. In suitable conditions, control of dandelions has been shown to be more effective and twice as fast as lawn herbicides containing 2,4-D, mecoprop and dicamba. Extensive work has been done on commercial formulation of the product, efficacy in the field and environmental safety. Registration is expected to be straightforward and it may become available in Canada within the next year or two.

## FUNGICIDES AND BACTERICIDES

### *Agrobacterium radiobacter*

*A. radiobacter* is a beneficial species of bacteria used as a biological control for crown gall (*A. tumefaciens*) on woody plants.

**Mode of Action:** *A. radiobacter* controls crown gall by disabling the pathogen at the point of infecting the plant. It is applied as an inoculant to susceptible plants or seeds before exposure to the disease, usually to stock before planting out.

**Formulation:** The bacteria are contained in a dust formulation that is mixed with water to make a slurry. The slurry is used as a seed treatment or a root dip. Only one product (Dygal®) is currently registered in Canada.

**Use:** The product is used to treat woody plants susceptible to crown gall, such as roses, clematis, chrysanthemums, flowering *Prunus* spp., willow, juniper and other ornamentals. It must be used by staff trained to handle it correctly and to prevent even brief exposure to sunlight, which kills the bacteria. It may not completely protect plants if they are planted where infected plants were grown before.

*A. radiobacter* is non-toxic and does not harm mammals, fish, insects and other non-target organisms.

• [Top](#)

### Sulfur

Products containing sulfur, a naturally occurring element, are sold for broad-spectrum control of fungi that cause plant diseases. Sulfur is also a miticide.

**Mode of Action:** The sulfur particles bind with fungal spores to prevent their germination. Sulfur does not have residual effects, therefore must be reapplied frequently to protect new foliage.

**Formulation:** Sulfur is available as ready-to-use and concentrated liquids, dusts and wettable powders.

*Use:* Sulfur controls black knot, black spot, leaf spots, powdery mildew, rusts, apple and pear scab and other fungal diseases. It also controls russet mites and rust mites. It is registered for use on foliage of roses, flowers, other ornamentals, as well as fruit trees and vegetables.

Use only on plants listed on labels as tolerant to sulfur. Some plants (such as Boston fern, melon, pears, etc.) may be injured by sulfur, therefore always check labels for phytotoxicity information.

Sulfur should not be used when temperatures are over 24°C and not within 30 days of using either dormant or summer oil sprays. It has low toxicity to mammals and is not toxic to fish, birds and other wildlife. Sulfur does not harm bees, but is toxic to beneficial predator mites.

• Top

## **Lime Sulfur**

Lime sulfur is a calcium sulfur compound that is a fungicide as well as an insecticide and miticide.

*Mode of Action:* Lime sulfur has broad-spectrum activity against fungi that cause plant disease. It also controls mites and some insects.

*Formulation:* Lime sulfur is sold as liquid concentrates to be mixed with water. It can be mixed with oil sprays for dormant applications only.

*Use:* Lime sulfur is used to control black knot, black spot, brown rot, powdery mildew, rusts, apple and pear scab, peach leaf curl and other fungal diseases. It is also used to control scales, spider mites, rust mites, aphids, mealybugs, peach borers and other insects. As a dormant spray, lime sulfur controls overwintering eggs of insects on fruit trees, bushes and woody ornamentals. Dormant sprays are more concentrated than growing season sprays and can be phytotoxic to dormant *Viburnum* spp. and some fruit and nut trees.

Growing season sprays are diluted to reduce phytotoxicity so they can be used on foliage of woody plants. Lime sulfur is phytotoxic to most actively growing plants, however, so use growing season sprays only on plants listed on label and at the correct dilution for this use.

Lime sulfur should not be applied when temperatures are above 26°C. It also should not be used within a month before or after oil sprays during the growing season.

Lime sulfur is moderately toxic to mammals and non-toxic to fish, birds, bees and other wildlife. It is toxic to beneficial mites.

• Top

## ***Typhula phacorrhiza***

Researchers at the University of Guelph have isolated a strain of the fungus *Typhula phacorrhiza* that is effective in controlling snow mold diseases caused by pathogenic *Typhula* spp. Most testing has been done in Ontario, however, some trials have been also done across the country. While it is not currently registered, the researchers are in the process of preparing the registration package for submission and hope to have a granular formulation on the market within a couple of years.

## **MOLLUSCICIDE**



Slug

### Ferric Phosphate

A naturally occurring mineral, ferric phosphate (or iron phosphate) has been recently registered in Canada to control slugs and snails. It is as effective as metaldehyde slug baits, but much less toxic to non-target animals and should be used instead.

*Mode of Action:* Slugs stop feeding immediately after eating ferric phosphate baits, then start to dry out. They may not die for several days, but damage from their feeding stops as soon as they take the bait.

*Formulation:* The ferric phosphate is incorporated into a granular pasta bait which is spread around plants where slugs are causing damage.

*Use:* Ferric phosphate controls slugs and snails. Unlike metaldehyde slug baits, ferric phosphate is not toxic to dogs and other animals and they are not attracted to it. It is non-toxic to birds, fish and other wildlife and does not harm ground beetles, earthworms and other beneficial organisms.

• [Top](#)

### Further Reading

Dreistadt, S. H. 1994. Pests of Landscape Trees and Shrubs: An Integrated Pest Management Guide. Pub. #3359, University of California. 327 pp. (From: ANR Publications, Univ. of Calif., 6701 San Pablo Ave., Oakland, CA 94608-1239. Tel: 800-994-8849 Web: <http://anrcatalog.ucdavis.edu/>)

Flint, M. L. and S. H. Dreistadt. 1998. Natural Enemies Handbook: The Illustrated Guide to Biological Pest Control. Pub. #3386. University of California. 154 pp. (From: ANR Publications, Univ. of Calif., 6701 San Pablo Ave., Oakland, CA 94608-1239. Tel: 800-994-8849 Web: <http://anrcatalog.ucdavis.edu/>)

Matteoni, J. A. and D. Elliott. 2000. Applied Biological Control Manual: Greenhouse and Protected Crops. Applied Bio-Nomics Ltd. (From: ABN, 11074 W. Saanich Rd., Sidney, BC V8L 5P5. Tel: 250-656-2123. E-mail: [bug@islandnet.com](mailto:bug@islandnet.com))

Quarles, W. 1999. Non-Toxic Weed Control in the Lawn and Garden. Common Sense Pest Control Quarterly. 15(3):4-14. (From: Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707. Tel: 510-524-2567.)

### Study Questions

1.   a) Describe the effect of high temperatures on plants, and  
      b) List three types of systems that have been invented to apply heat to vegetation.
2.   a) How do mulches work to suppress weeds and,  
      b) When should they be applied?
3.   Insect parasitic nematodes are generally not effective in what type of conditions?
4.   Answer true or false for the following:  
      \_\_\_\_ There are over 20 species of beneficial insects sold for use outdoors.



\_\_\_\_\_ Aphid midges can be used both in greenhouse and on outdoor plants to control aphids

\_\_\_\_\_ There are very few native lady beetle species in BC, so it is advisable to release lady beetles bought from commercial suppliers.

\_\_\_\_\_ *Bacillus thuringiensis* is a biological control and a registered pesticide.

5. Describe the mode of action of: a) horticultural oils; b) tebufenozide; c) sulfur

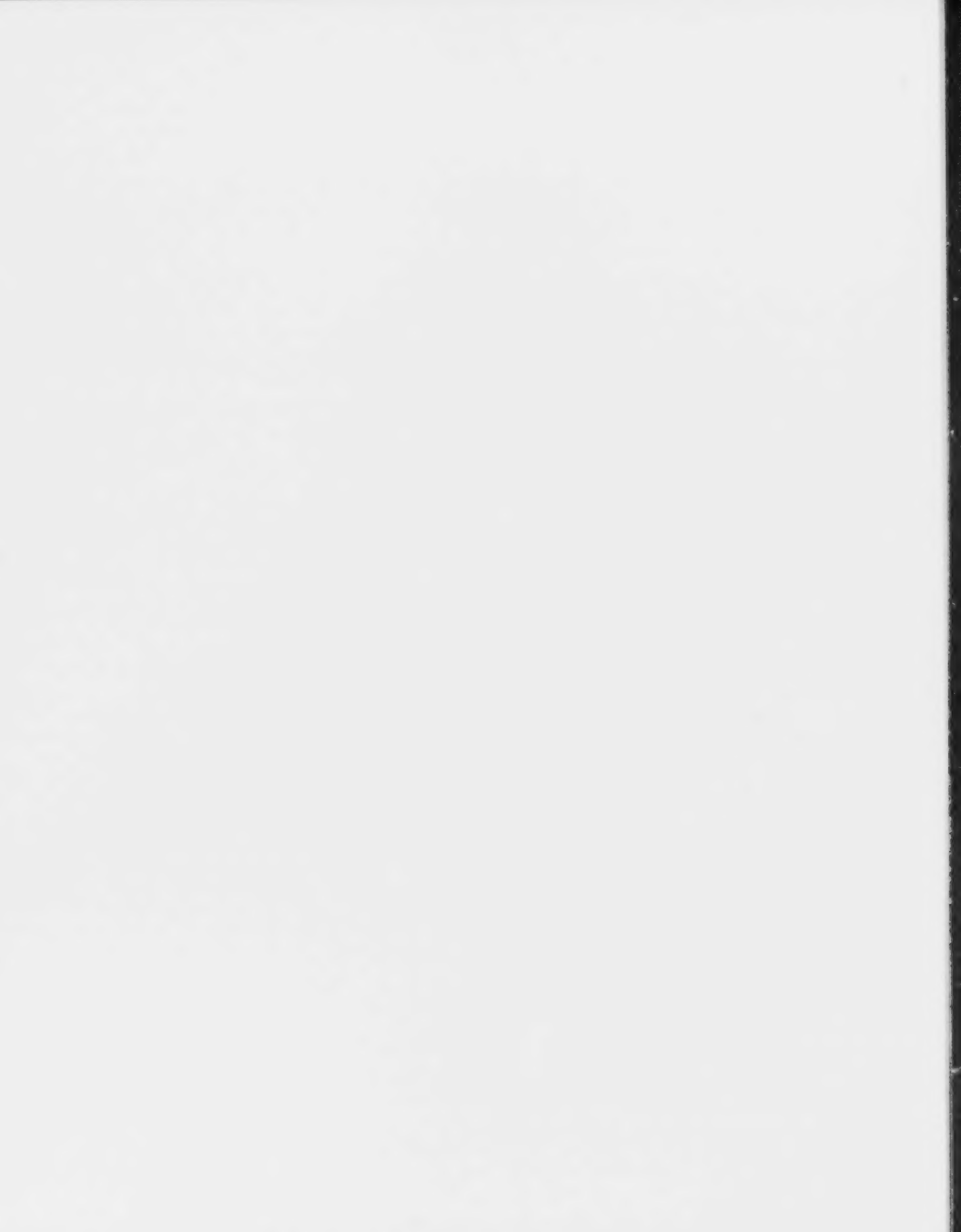
6. Define "botanical pesticides" and give two examples.

[Return to Table of Contents](#)

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.





## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

#### Chapter 4 — IPM for Vegetation

##### *Learning Objectives*

When you have completed this lesson, you should be able to:

1. *Classify common landscape sites into three categories according to maintenance level required for problem vegetation.*
2. *List ways to prevent weed problems in hard-surfaced sites and in planted beds.*
3. *Know where to look for help in identifying plants.*
4. *List six characteristics of plant populations that can be counted or measured in a monitoring program.*
5. *Give examples of vegetation treatment thresholds.*
6. *Describe physical and mechanical controls for vegetation.*
7. *List guidelines for selecting appropriate herbicides.*
8. *Describe the role of evaluation in an IPM program for vegetation.*

##### *Introduction*

IPM for vegetation (also called integrated vegetation management or IVM) is an important area of pest management in BC landscapes, particularly in coastal areas where the climate favours plant growth nearly year-around. Vegetation management described in this chapter covers:

- areas where no plant growth is desirable, such as paved surfaces and sidewalks;
- areas where low-growing or minimal vegetation is acceptable, such as along fence lines and around lamp posts, and
- planted areas, where weeds occur among desirable plants in flower and shrub beds.

Problem vegetation is any plant in the wrong place. This includes herbaceous annuals, biennials, and perennials as well as woody plants and mosses. As described in Chapter 2, using a system for categorizing sites according to maintenance level can help in planning an IPM program.

##### **Facility Categories**

Examples of sites that might be included in each category include:

- Class A - High level of service: formal display beds, high traffic areas, cemeteries, playing courts, botanical gardens, city hall grounds, residential yards.
- Class B - Moderate level of service: boulevards and medians, general park and playground area, parking lot perimeters, sidewalks, perennial borders, residential backyards.
- Class C - Low level of service: utility areas, works yards, natural parks, low use recreational areas and trails, fence lines.



*Urban Landscaping*

The following section describes steps in an IPM program for vegetation and gives examples of techniques currently available to vegetation managers. This information is intended as a starting point, to be adapted to specific sites and improved as new products and methods are developed.

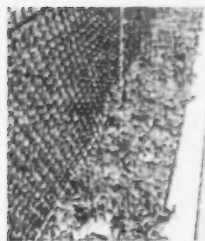
• [Top](#)

## **Prevention**

Designing facilities to prevent undesirable plants from becoming a problem is the key to long-term vegetation management. Sites can be designed or modified to eliminate "weed zones", which are trouble spots that are repeatedly filled by invading weeds.

### **Hard-Surfaced Areas**

Examples of design changes that can make a large difference in future weed problems, include:



*Weed Zone*

- Install a paved or mulched mow strip under fence lines to block weed growth and eliminate the need to use herbicides or trimmers.
- Extend asphalt surfaces, such as playing courts or parking lots, past the outside edge of fencing so there is no "weed zone" under the fence line proper.
- Install brick-patterned concrete or asphalt instead of using bricks or paving stones for sidewalks, driveway and other paved surfaces. This is most applicable in coastal areas of BC, where weeds growing in cracks is a serious problem; some municipalities have incorporated this design requirement into local building codes.
- Fill cracks in asphalt and concrete surfaces with a sealant to remove germination sites.

### **Planted Beds**

Ways to avoid future weed problems at the design and construction stage of shrub beds, borders and other planted sites, include:

- Use weed-free nursery stock and bedding plants to prevent the importation of weed seeds.

- Prepare the soil to provide the best growing conditions for the desired plants so that they can out-compete weeds.
- Before planting new beds, deplete the seed bank in the soil. Do this by allowing weed seeds to germinate, then cultivate to kill the seedlings; repeat this 2-4 times, if possible.
- Apply organic or geotextile mulches to prevent weed from emerging or becoming established (see Chapter 3).
- Plant aggressive ground-covers and massed plantings that rapidly cover the soil surface and reduce the space, nutrients and light available to weeds.

• Top

## Identification

Collect leaves or whole plants and identify them to species, if possible. Find out whether the plants are annuals or perennials, as well as other characteristics, such as whether they are grasses, broadleaf weeds, noxious weeds or woody plants. This information will help in deciding the best management methods and when to use them.

For plants that cannot be positively identified, collect leaf or flower samples or whole plants and press them, if possible, to preserve them for future diagnosis.

Identification resources include:

- reference books, plant guides (suggestions are listed at the end of this chapter)
- resources on the internet
- staff at garden centres, community colleges, botanical gardens
- professional diagnostic services

**Note:** Professional services and companies can send samples to the provincial Plant Diagnostic Laboratory, Ministry of Agriculture, Food and Fisheries, 1767 Angus Campbell Road, Abbotsford, B.C. V3G 2M3. Phone: 604-556-3126 (there is a charge for this service).

• Top

## Monitoring

Monitoring programs for vegetation are based on regular inspections. These can be simple visual inspections (rough estimations) to check for the presence of unwanted plants and their stage of growth. There are also characteristics of plant populations, however, that can be counted or measured to arrive at a more accurate estimate. This will be more useful than visual inspections in setting thresholds and assessing progress. Examples include:

- number of plants along a transect or in an area (see Chapter 5 for counting methods)
- percent coverage of a site
- average height
- average rate of growth
- stage of growth (i.e., recently germinated, forming flowers or seed heads, dormant, etc.)

- species of plants present

**Which Method:** The choice of monitoring method depends on the site and the user. Once a method is chosen, the same one should be used each time so that counts and averages can be compared from one year to the next. For more information on the principles of sampling, see Chapter 1.

**How Often:** Frequency of monitoring depends on the category of the site, its history of weed problems and the local climate, as well as the budget. Most pest managers find 1-4 inspections per growing season sufficient for problem vegetation. On low maintenance sites, occasional visual inspections may be the only monitoring required. On high maintenance sites (i.e., Class A), the vegetation situation may be more accurately estimated by taking quantitative measurements.

Vegetation records should be kept for each major site. It is important to keep written records of all counts, as well as notes from visual inspections for future reference. Some managers also find it useful to take photographs for comparison from year to year.

• Top

## Action Decisions

Given the large variety of sites and the many species of plants that may be a problem in landscapes, it is hard to generalize about injury and action levels. How much vegetation is tolerable depends on where the weeds are growing, the maintenance category of the facility and the consequences of leaving weeds untreated. Three main factors to consider in setting injury levels include:

a) Safety and security of site users, including:

- degree of trip or slip hazards from plants
- blocking sight-lines on roadways, parking lot exits
- concealment of signs, curbs or ditches by weeds

b) Potential for damage to structures and facilities, including:

- hard-surfaced sidewalks, playing courts and parking lots
- fence-lines, sign posts, culverts and ditch banks
- building foundations
- fire hazards

c) Aesthetic standards, which are affected by:

- visibility and use pattern of the site
- nature of the surrounding area (i.e., rural, urban, natural vegetation)
- nearby facilities that might be affected
- nearness to sensitive natural areas

It is important to develop written injury and action levels for major sites, particularly those requiring higher levels of service (i.e., Class A and B sites). This may take a few seasons to work out, using monitoring records and annual evaluations to fine-tune the levels. Where weed treatments are rarely used, as is often the case on low maintenance sites (i.e., Class C), developing action levels may be a low priority. In such sites, simpler criteria, such as degree of fire hazard or presence of noxious



weeds might be suitable.

For any sites where herbicides use is being considered, decision levels should be quantitative (stated in terms of numbers or measurements). Examples of injury levels are:

- number of plants per linear metre of fence line or curb
- number of weeds per square metre of shrub bed or display border
- average height of vegetation around signs, guardrails, ditches or sight lines along roads
- number of plants of particular problem species (i.e., blackberry, Scotch broom, poplar) present on a site
- presence of any plants of a noxious weed species

For future reference and to help in later evaluation, write down the criteria used to set the injury and action levels. Although there may not appear to be much difference between injury and action levels for vegetation when herbicides are used, other types of treatments may have different action levels. For example, equipment that uses heat to kill vegetation is more effective on seedlings than established plants, therefore treatments could be timed to coincide with a flush of newly germinating weeds.

• Top

## Treatments

Control of annual weeds should focus on preventing seeds from spreading and preventing dormant seeds in the soil from germinating. Controls for established perennials are usually most effective before the plants bloom, when nutrient reserves in the roots are at their lowest and the plant is least able to grow new leaves.

### Physical and Mechanical Controls

- Remove weed seeds and organic material from cracks in hard surfaces, by regularly sweeping or flushing with water.
- Manually remove plants. Complete removal of roots is necessary for long term control of plants that resprout after cutting (for a weed pulling tool, see text box).
- Cultivate soil to kill weeds; use a tractor blade to scrape a gravel or sand surface to destroy weeds.



*Paving Bricks with Weeds*

- Mow or use string trimmers on light vegetation. Mowing should be timed to prevent seed heads from forming and to maintain acceptable aesthetic standards.
- Use chainsaws, brushsaws or heavy-duty mowers to control woody plants. Repeated mowing or cutting top growth of bushy weed species depletes the energy reserves of the root.
- Apply heat using flamers, hot water or steam applicators, or infra-red radiation generating equipment (for more information, see Chapter 3).

### Weed Wrench

An ingenious tool for pulling Scotch broom and gorse is available from a US supplier\*. The tool has jaws that grip the stem of a plant as it is pried out of the ground. It can be used on large, well-established broom plants and other shrubs, as well as established blackberry thickets.



\*Available from: New Tribe, Grants Pass, Oregon

### Chemical Controls

- If chemical controls are necessary, the least toxic, effective herbicide should be used. Select the product according to the following guidelines. Make sure it is:
- effective and registered for the specific weed type
- applied as a spot treatment instead of broadcast application where possible
- applied at the right time to have the greatest effect on target plants
- does not have long-term residual effects if the area is to be planted later

**Preferred Herbicides:** Fatty acid herbicides are of low toxicity and are effective on annual weeds and some perennials (for more information, see Chapter 3).

**Other Herbicides:** There are two general types of herbicides: pre-emergent herbicides, which are applied to soil before weed seeds germinate, and post-emergent herbicides, which are used on plants in an actively growing stage, before seed heads form. Post-emergent herbicides can be divided into selective herbicides and non-selective herbicides.

- Selective herbicides affect some types of plants, but not others. For example, several herbicides kill broadleaf weeds, but do not affect grasses.
- Non-selective herbicides can kill any type of plant. They are used to control all vegetation in an area or as spot treatments on deep-rooted plants and those that spread by rhizomes, especially in sites where there is no desirable vegetation present.

### Controlling Himalayan Blackberry (*Rubus discolor*)

This vigorous blackberry is an invasive plant that grows rampantly in south coastal BC. It often develops into extensive thickets along rights-of way, on vacant lots and other disturbed areas. If done at the right time, a combination of mechanical and chemical controls can be effective in eradicating it from a site.

First, the entire thicket must be mowed or cut down in May or early June to remove all woody top growth. The roots will sprout new shoots, which should be left to grow for the summer. In early September, treat the plants with the non-selective herbicide glyphosate. At that time of year, the herbicide is readily translocated to the roots. The plants may not appear to be affected for some time, however, they do not grow back in the spring.

**Application Methods:** The most target-specific application techniques available should be used where practical. This includes using back-pack or hand-held sprayers, low-volume closed-system applicators, and "wipe-on" applicators.

For more precautions and guidelines for using pesticides in landscapes, see Chapter 11.

[• Top](#)

## Evaluation

After any type of treatment, the treated areas should be inspected for results at intervals appropriate to the type of treatment. For example, schedule an inspection 1-3 weeks after an herbicide treatment.

Use this information, along with other monitoring records, observations from field staff, feedback from clients, budget records, etc. to assess the effectiveness of the vegetation IPM program and find ways to improve it for next year. After several seasons of recording and evaluating, a long-term decrease in the vegetation problems should be noticeable.

## Further Reading

\_\_\_\_\_. 1996. Grower's Weed Identification Handbook. University of California. 590 pp. (From: ANR Communication Services, Univ. of Calif., 6701 San Pablo Ave., Oakland, CA 94608  
Web: <http://anrcatalog.ucdavis.edu/>).

Cranston, R., D. Ralph and B. Wikeem. 1996. Field Guide to Noxious and Other Selected Weeds of British Columbia. BC Ministry of Agriculture, Food and Fisheries, BC Ministry of Forests, Victoria, BC 79 pp. Olkowski, W., S. Daar, H. Olkowski, 1991. Common-Sense Pest Control. The Taunton Press, Newtown, CT. (From: Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707  
Web: <http://www.birc.org/>).

Quarles, W. 1999. Non-Toxic Weed Control in the Lawn and Garden. Common Sense Pest Control Quarterly. 15(3):4-14. (From: Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707.  
Web: <http://www.birc.org/>) Whitsen, T.D. et al. 1991. Weeds of the West. University of Wyoming, Judson, Wyoming. 630 pp.

[• Top](#)

## Study Questions

1. List three examples of changes that can made to the design of hard surfaced areas to prevent weed problems in the future.
2. Why is it important to identify problem plants and learn their characteristics?
3. Fill in the blanks with the appropriate phrase:
  - a. Which method of monitoring to use depends on  
\_\_\_\_\_
  - b. How often to monitor depends on  
\_\_\_\_\_

4. List three main factors to consider in setting injury levels for problem vegetation.
5. Why are controls for established perennial weeds usually most effective before the plants bloom?
6. Answer true or false for the following:  
  
\_\_\_\_\_ Mowing to control vegetation should be done after plants have gone to seed.  
  
\_\_\_\_\_ Fatty acid herbicides are effective on annual weeds.  
  
\_\_\_\_\_ Post-emergent herbicides are used to control weed seeds in flower beds.  
  
\_\_\_\_\_ Repeated mowing depletes the energy reserves in roots of woody plants.

[Return to Table of Contents](#)

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.



## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

#### Chapter 5 — IPM for Weeds in Turf

##### *Learning Objectives*

When you have completed this lesson, you should be able to:

1. *Classify common types of turf sites into three categories according to maintenance level.*
2. *List seven management methods that help prevent weed problems in turf.*
3. *Know where to look for help in identifying weeds.*
4. *Describe three ways to count weed populations in turf.*
5. *Give examples of treatment thresholds for three categories of turf.*
6. *Describe two physical controls for turf weeds.*
7. *List guidelines for selecting appropriate herbicides.*
8. *Describe the role of evaluation in a turf IPM program.*

##### *Introduction*

IPM programs for weeds in turf are well-developed in BC. Turfgrasses are used for lawns because they are tough, hardy and adaptable plants. Given good conditions, vigorous turf will out-grow most other kinds of plants, therefore preventing weed problems through good management should be the primary approach. As described in Chapter 2, using a system for categorizing sites according to maintenance level can help in planning an IPM program.

##### *Facility Categories*

Examples of turfgrass sites that might be included in each category include:

- Class A - High level of service: fine ornamental lawns, golf and lawn bowling greens, irrigated sports fields.
- Class B - Moderate level of service: general park areas, residential and commercial lawns, boulevards, recreational fields, golf fairways.
- Class C - Low level of service: meadows, picnic areas, rough grass, undeveloped and naturalized areas.

The following section describes the steps in an IPM program for turf weeds and gives examples of techniques currently available to turf managers. This information is intended as a starting point, to be adapted to suit specific sites and improved as new products and methods are developed.

• [Top](#)

## **Prevention**

When designing and planting turf areas, plan for long-term weed management by starting with the correct drainage, soil preparation and choice of turfgrass cultivars. Follow this with good turf management practices to ensure healthy, vigorous turf. A general list of management methods that prevent weed problems and other pests (also called "cultural controls" in some references) includes:

- a) Select turfgrass cultivars suited to local conditions and intended use.
  - For example, choose wear resistant perennial rye grass for sports fields or choose shade-tolerant fescues for shaded areas in parks. Invest in the best quality seed available.
- b) Use fertilizers that suit turfgrass nutritional requirements.
  - For large or high profile facilities, regular soil testing, and possibly tissue analysis, may be advisable to make sure that lime and fertilizer requirements are being met.
  - Adjust application rates to avoid nutrient imbalances and to prevent leaching of soluble fertilizers beyond the root zone.
- c) Follow good irrigation practices.
  - Water deeply and infrequently. Avoid shallow watering, which promotes shallow rooting and accumulation of thatch.
  - Test for moisture requirements rather than relying on automatically timed intervals. Relate irrigation cycles to the local evapo-transpiration rates, soil type, drainage characteristics and species of turfgrass.
  - Have manual overrides on automatic watering systems that are easy to adjust for unusually wet or dry conditions or use automatic rain delays to shut off irrigation during rainy periods.
- d) Use correct mowing practices.
  - Keep the mower height as high as possible for the turfgrass species and use of the site. This gives the grass plants more leaf area, so they grow more vigorously, with deeper roots and are better able to compete with weeds. The dense turf also shades the soil, which prevents weed seeds from germinating. Most turf grass species used in parks, home lawns and recreational fields can be mowed at a height of 5-7 cm.
  - Maintain sharp blades on mowers and mow as often as work schedules and budgets allow. For most turf, scheduling mowing according to the growth rate of the turf, so that mowing removes about 1/3 of the plant height, gives the best results.
  - Use mulching mowers and leave the grass cuttings on the turf to provide nutrients. This has been shown to replace up to 15% of the nitrogen fertilizer required and does not cause thatch to build up (but may not be advisable in cool, wet spring conditions when turf is growing rapidly).
- e) Keep thatch to an optimum thickness.

A moderate layer of thatch (1-2 cm) is beneficial for most turf because it insulates roots from temperature extremes, reduces water loss and acts as a cushion to reduce compaction from wear.



- If necessary, remove excessive thatch by verticulating or raking.
- Where *Poa annua* is a problem, avoid de-thatching operations in early fall or spring when weed seeds are germinating.
- Leave as much soil covered as possible to reduce germination of weed seeds.

f) Manage to reduce soil compaction.

- Provide mechanical aeration as required, preferably with hollow core aerators instead of solid core equipment. How often to aerate depends on the type of turf and use patterns.
- Avoid compaction from overuse. For example, rotate goal mouth areas and entrance points onto turf areas for people and equipment; alternate direction of mowing; establish a sports field closure policy during poor weather and limit play on sensitive or stressed sports fields.



Closed Sports Field

g) Promptly repair worn or damaged areas.

- Use overseeding, re-seeding or re-sodding to close openings in the turf and increase the density of turf plants. This prevents weeds from germinating and becoming established.

The key to managing turf weeds is preventing, and correcting, conditions that stress the turf plants. When weed populations exceed tolerance levels in turf it is usually because the grass has been thinned out by poor conditions, such as drought, compaction, poor drainage, mowing too low, etc. Any openings in the turf will be colonized by weeds adapted to those conditions. Noting which species of weeds appear, and where, can help you diagnose the type of stress the turf is experiencing (see text box).

#### Weeds as Indicators of Stress Conditions in Lawns

|                                           |                                             |
|-------------------------------------------|---------------------------------------------|
| Annual Bluegrass ( <i>Poa annua</i> )     | low fertility, compaction, mowing too short |
| Buttercup ( <i>Ranunculus</i> spp.)       |                                             |
| Chickweed ( <i>Stellaria media</i> )      | Excessive moisture                          |
| Clover ( <i>Trifolium repens</i> )        | Excessive moisture                          |
| Crabgrass ( <i>Digitaria</i> spp.)        | Thin grass, excessive moisture              |
| Dandelion ( <i>Taraxacum officinale</i> ) | Low nitrogen, drought, compaction           |
|                                           | Thin grass, low fertility, compaction       |
| Dock ( <i>Rumex</i> spp.)                 | Thin grass, low fertility, mowing too short |
| English Daisy ( <i>Bellis perennis</i> )  | Thin grass                                  |
| Moss (various)                            | Excessive moisture                          |
| Plantain ( <i>Plantago</i> sp.)           | Low fertility, low pH, excessive moisture   |
|                                           | Heavy shade, low fertility, low pH          |
|                                           | Low fertility, mowing too short             |

Adapted from: Olkowski, W., S. Daar, H. Olkowski, 1991.  
Common-sense Pest Control. The Taunton Press, Newtown, CT. pg. 556.



[Top](#)

## Identification

Collect leaves or whole plants and identify to species if possible. Find out whether the plants are annuals or perennials, as well as other characteristics, such as whether they are grasses, broadleaf weeds or noxious weeds. This information will help in deciding the best management methods and when to use them. Weeds that cannot be positively identified should be carefully collected, and pressed if necessary, to preserve them for future diagnosis.

Identification resources include:

- reference books, plant guides (see Further Reading, at the end of this chapter)
- resources on the internet
- staff at garden centres, community colleges, botanical gardens
- professional diagnostic services

**Note:** Professional services and companies can send samples to the provincial Plant Diagnostic Laboratory, Ministry of Agriculture, Food and Fisheries, 1767 Angus Campbell Road, Abbotsford, B.C. V3G 2M3. Phone: 604-556-3126 (there is a charge for this service).

[Top](#)

## Monitoring

Most monitoring programs for weeds in turf are based on visual inspections (rough estimations) and on weed counts, which give a more accurate picture of the weed situation. For more information on the principles of sampling, see Chapter 1.

It is important to keep written records of all counts, as well as notes from visual inspections for future reference. Some turf managers also find it useful to keep photographs as a record.

## Counting Methods

Methods for counting weed populations in turf:

- **Transect Method:** Use a rope or string to stake out a 10 m transect (straight line) through an average section of turf. Walk along the line and record the plants you see in a 10 cm<sup>2</sup> area at 10 points along this transect; check 10 or more transects per site. Averaging the scores from each type of site gives a percentage of weeds in the turf. Transect lines can be marked or knotted to show where to sample or you can pace along the length of the line and record the plants seen near your toe after each large stride.
- **Grid Method:** Make a wire or wood frame, 1 metre square. Lay it down, randomly, on the turf and count all of the weeds inside the frame. Count at least 10 squares per site. Average the scores to arrive at a percentage of weed cover.
- **Centreline Method:** Walk the center of sports fields from goalpost to goalpost and estimate percent weed cover in a 10 cm<sup>2</sup> area at every second step.



**Which Method:** The choice of monitoring method depends on the site and the user. Once a method is chosen, the same one should be used each time so that counts and averages can be compared from one year to the next.

**When and How Often:** The monitoring schedule depends on the category of the site, its history of weed problems, the local climate, as well the budget. Schedule monitoring to coincide with periods of active vegetative growth or flowering periods, when some weeds are easiest to see.

#### *Walking a Transect*

On low maintenance sites, an occasional visual inspection may be the only monitoring required. On intermediate sites, if a visual inspection shows cause for concern, then the weed population can be more accurately estimated by counting weed populations. On high profile turf, weed counts are usually done once or twice a year (early spring and late summer).

• Top

### **Action Decisions**

On general use turf, in parks and other public facilities, the need for treatment often depends on how many weeds the public will tolerate. On sports turf, safety considerations also influence treatment decisions because bare areas or large weedy patches can increase the slipping hazard. Playability is a key consideration in deciding when to treat on golf course and lawn bowling greens.

Examples of injury levels used by turf managers in BC are:

- Class A Sites: Usually maintained relatively "weed free". Turf with 5-10% weed cover is often accepted by users as "weed free". A common action level for herbicide treatment is 10-15% weed cover.
- Class B Sites: Some weeds are acceptable, providing the function of the site is not compromised. Acceptable levels used by municipalities for such sites range from 20% to 50% weed cover.
- Class C Sites: Controls may only be needed in the interest of public safety (i.e., to maintain sight lines, remove a fire hazard) or if noxious weeds are present or other weed populations threaten to contaminate nearby high value facilities. Acceptable levels are often over 50% weed cover.

Develop written injury and action levels using monitoring information for major sites or for each class of site. These should be quantitative (stated in terms of a number or measurement) for any sites where herbicides use is being considered. For future reference and to help in later evaluation, write down the criteria you use to make action decisions, such as percentage of weed cover, presence of noxious weeds species, risk of spread to adjacent turf, cost, etc.

Although there may not appear to be much difference between injury and action levels for turf weeds when herbicides are used, other types of treatments may have different action levels. For example, it may be justifiable to use a back-pack infra-red weeder to control dandelions in a public park to treat a lower weed population level than would be feasible using a herbicide. This is because using the pesticide would involve complying with regulatory requirements and public notification guidelines that do not apply to the infra-red weeder, which could be used at any time.

#### **Setting an Injury Level for Weeds in a Lawn**

When you ask someone how many weeds they would tolerate in their front lawn, their first reaction is often "None!". But does "none" really equal "zero"? One study conducted in California, found that people did not notice that there were weeds in a lawn until weed counts exceeded 5-10%\*. Sounds unlikely?

Try this —

First, find some areas of turf that look "fine" to you, then count the weeds in 10 transects or grids (as described above) and average the counts. Do the same for turf that you consider looks "marginal" and again for turf areas that look "poor".

The whole exercise can be done fairly quickly. It should give you a better idea of acceptable and unacceptable weed counts, which can be used to set realistic injury and action levels.

\* Olkowski, W., S. Daar, H. Olkowski, 1991. Common-Sense Pest Control. The Taunton Press, Newtown, CT, pg. 55.

• Top

## **Treatments**

Knowing whether a weed is an annual or a perennial is important because it affects treatment decisions.

For example, control of annual weeds would focus on preventing seeds from spreading and on preventing dormant seeds in the soil from germinating (i.e., by minimizing disturbances to the soil or by applying corn gluten herbicides if they become available in Canada). For perennial weeds, controls are usually used before the plants bloom, when nutrient reserves in the roots are at their lowest and the plant is least able to grow new leaves.

## **Physical and Mechanical Controls**

- Hand-pull small populations of weeds. There are several well-designed hand tools on the market that make weed pulling more efficient. This is easiest when the soil is moist, but can be done any time of year and by anyone working on the site. Care should be taken to disturb the soil as little as possible. As a weed is pulled out, it is a good idea to sprinkle turfgrass seed in the opening to close the gap in the turf quickly and prevent weed seeds in the soil from germinating.
- Use a hand-held flamer or infra-red radiation applicator with a probe tip to control broadleaf weeds in turf (for heat treatment information, see Chapter 3).

## **Chemical Controls**

The need to use herbicides on general use turf usually shows that turf management methods need to be improved. If herbicide use is judged necessary, however, select the product according to the following guidelines. Make sure the product selected is:

- effective and registered for the specific weed type
- applied as a spot treatment instead of a broadcast application wherever possible

- not phytotoxic to desirable turf species (i.e., some common turf herbicides kill bentgrasses)
- applied at the right time to have the greatest effect on target plants

Preferred herbicides, including a promising mycoherbicide for dandelions, are discussed in Chapter 3. For precautions and guidelines for using pesticides in landscapes, see Chapter 11.

• Top

## **Evaluation**

After any type of treatment, turf areas should be inspected for results at intervals appropriate to the type of treatment. For example, schedule an inspection 1-2 weeks after an herbicide treatment.

Use this information, along with other monitoring records, observations from field staff, feedback from clients, budget records, etc. to assess the effectiveness of the turf IPM program and find ways to improve it for next year. After several seasons of recording and evaluating, a long-term trend toward better turf quality and low weed populations should be noticeable.

If monitoring shows that weed populations continue to rise, it is essential to re-evaluate turf management practices. The goal should be to improve the health of the turf so that it is more competitive with weeds.

## **Further Reading**

\_\_\_\_\_. 1996. *Grower's Weed Identification Handbook*. University of California. 590 pp. (From: ANR Communication Services, Univ. of Calif., 6701 San Pablo Ave., Oakland, CA 94608  
Web: <http://anrcatalog.ucdavis.edu/>).

Cranston, R., D. Ralph and B. Wikeem. 1996. *Field Guide to Noxious and Other Selected Weeds of British Columbia*. BC Ministry of Agriculture, Food and Fisheries, BC Ministry of Forests, Victoria, BC 79 pp. Olkowski, W., S. Daar, H. Olkowski, 1991. *Common-Sense Pest Control*. The Taunton Press, Newtown, CT. (From: Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707  
Web: <http://www.birc.org/>).

Olkowski, W., S. Daar, H. Olkowski, 1991. *Common-Sense Pest Control*. The Taunton Press, Newtown, CT. (From: Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707. Tel: 510-524-2567 Web: <http://www.birc.org/>).

Quarles, W. 1999. Non-Toxic Weed Control in the Lawn and Garden. *Common Sense Pest Control Quarterly*. 15(3):4-14. (From: Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707. Web: <http://www.birc.org/>) Whitsen, T.D. et al. 1991. *Weeds of the West*. University of Wyoming, Judson, Wyoming. 630 pp.

Whitsen, T.D. et al. 1991. *Weeds of the West*. University of Wyoming, Judson, Wyoming. 630 pp.

• Top

## **Study Questions**

1. Why is prevention, through good turf management, the primary approach to managing weeds in turf?

2. Answer true or false for the following:

\_\_\_\_\_ Leaving grass cuttings on turf after mowing causes thatch to build up.

\_\_\_\_\_ Turf should be watered deeply and often, regardless of the weather.

\_\_\_\_\_ A 1-2 cm layer of thatch is beneficial to a lawn.

\_\_\_\_\_ Setting mowing heights as high as possible helps turfgrasses grow deeper roots.

3. List 3 methods for counting weed populations in turf.

4. Match the type of turf (*column A*) with factors that influence action decisions on treating for weeds (*column B*)

5. Fill in the blanks: To control annual weeds, you would focus on preventing \_\_\_\_\_ and preventing \_\_\_\_\_

[Return to Table of Contents](#)

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.



## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

#### Chapter 6 — IPM for Insects in Turf

##### *Learning Objectives*

When you have completed this lesson, you should be able to:

1. *Classify common types of turf sites into three categories according to maintenance level.*
2. *List methods that prevent insect problems in turf.*
3. *Know where to look for help in identifying insects.*
4. *Describe two monitoring methods used for turf insects.*
5. *Describe the use of insect parasitic nematodes to control turf insects.*
6. *List general guidelines for using insecticides to control turf insects.*
7. *Describe the role of evaluation in an IPM program for turf insects.*
8. *Describe monitoring methods, give examples of treatments thresholds and treatments for European crane fly, white grubs, black turfgrass *Ataenius* and sod webworms.*

##### *Introduction*

Insects are generally less of a problem in turf in BC than in other areas of Canada. The most common problems are: 'leatherjackets', which are the larvae of the European crane fly (*Tipula paludosa*); white grubs, which are the larvae of May or June beetles (*Phyllophaga* spp.); black turfgrass *Ataenius* (*Ataenius spretulus*) and sod webworms (*Crambinus* spp.). Cutworms (larvae of Noctuid moths), leafhoppers and chinch bugs can also be a problem.

Given good management, turf usually out-grows moderate insect damage without need for treatment. It is not uncommon, however, for raccoons, crows and other animals, to dig up turf in search of insects, causing much more damage than the insects.

As described in Chapter 2, using a system for categorizing sites according to maintenance level can help in planning an IPM program.

##### **Facility Categories**

Examples of turfgrass sites that might be included in each category include:

Class A - High level of service: fine ornamental lawns, golf and lawn bowling greens, irrigated sports field.

Class B - Moderate level of service: general park areas, residential and commercial lawns, boulevards, recreational fields, golf fairways.

Class C - Low level of service: meadows, picnic areas, rough grass, undeveloped and naturalized areas.

The following section describes the general steps in an IPM program for turf insects and gives examples of techniques currently available to turf managers. Examples of IPM information about four common turfgrass insects is also included at the end of the chapter. This information is intended as a starting point, to be adapted to suit specific sites and improved as new products and methods are developed.

• [Top](#)

## ***Prevention***

The elements of prevention (also called "cultural controls" in some references) for turf pests involve using optimum site design and management. When designing and planting turf areas, plan for long-term insect management by starting with the correct drainage, soil preparation and choice of turfgrass cultivars adapted to the conditions. Follow this with turf management practices that ensure healthy, vigorous turf (see Chapter 5 for additional management methods that contribute to healthy turf).

### **Plant Pest-resistant Turfgrasses**

On sites where chewing insects, such as sod webworm, are a chronic problem, consider renovating and reseeding with grasses containing endophytic fungi. Some cultivars of perennial rye grass and tall, turf-type fescues have high levels of endophytic fungi in the leaves. These fungi produce toxins that repel or kill leaf- and stem-feeding insects (they do not affect root-feeding species, such as leatherjackets or white grubs). Endophytic grasses must not be planted where livestock may graze.

• [Top](#)

## ***Identification***

Correct identification of turf pests is essential because monitoring and treatment methods must be tailored to a particular species. Once a problem species is identified, then information about its life cycle can be used to pinpoint when treatments will have the greatest effect and what preventative measures would be most effective.

If you suspect an insect problem, search carefully among leaves and in thatch. Fold back a section of sod or use a soil probe or cup cutter to remove a section of turf. Inspect the thatch layer, roots and soil for larvae, pupae and adult insects. Collect insects and identify them from guides and other references or preserve them for later identification by an expert.

Identification resources include:

- reference books, plant guides (suggestions are listed at the end of the chapter)
- resources on the internet
- staff at garden centres, community colleges, botanical gardens



- professional diagnostic services

Note: Professional services and companies can send samples to the provincial Plant Diagnostic Laboratory, Ministry of Agriculture, Food and Fisheries, 1767 Angus Campbell Road, Abbotsford, B.C. V3G 2M3. Phone: 604-556-3126 (there is a charge for this service).

• [Top](#)

## Monitoring

Turf insect populations can be estimated by visual inspections or determined more accurately using one of the counting methods described below.

### Visual Inspections

Walk over the turf areas, noting:

- damaged areas, which may show up as patches of wilting, yellowing, or browning turf or bare areas
  - signs that birds or other animals are pulling up the turf, indicating the possible presence of insects
- Record information on a map or diagram for future reference.

For close visual inspections, use a hand lens and a soil probe or other tool to search deep in the thatch layer and root zone. Look for:

- life stages of insects, such as larvae or pupae, on the surface or among the roots in the soil
- symptoms of chewing or sucking on leaf blades, missing leaf blades
- silken webbing in the thatch layer

### Counting Methods

- Fold back a measured section of sod or remove a plug of sod with a golf course cup cutter or other tool, then count and record the insects found among the roots. Replace the sod.
- Soak a measured area of turf with soapy water or a pyrethrins solution (see text box). This irritates insects and drives them to the surface where they can be counted.
- Cut out a measured section of sod and soak in a bucket filled with a saturated solution of salt water (add salt until no more will dissolve). Count the larvae that float to the top. This is a destructive sampling method that would not be appropriate for most landscape turf.

#### Soap Drench for Monitoring Turf Insects

Mix 1-2 tablespoons of liquid dish soap (not detergent) in a gallon of water. It is not a good idea to use more soap per gallon, because concentrated soap solutions can burn the grass leaves. Irritant solutions are most useful for active insects and larvae, such as leatherjackets and sod webworms.

Two ways to use the drench are:

- Mark an area of turf and use a watering can to soak the turf evenly with the soapy water.

Watch closely for 10-15 minutes to spot larvae wiggling to the surface.

- Cut out the bottom of a large tin can (1/2 gallon is a good size), then push the bottomless can 5-10 cm deep into the turf. Pour soapy water into the can and watch as it soaks in for larvae coming to the surface.

You can use 1 tablespoon of a 1-2% pyrethrins product instead of the soap.

For future reference, it is important to keep written records of counts as well as notes and maps of damage from visual inspections. Some turf managers also find it useful to keep photographs as a record.

### Useful Equivalents for Converting Sampling Areas

References on turf pest management from the US and Canada use a variety of measurements, in both imperial and metric measuring systems. The chart below is included to help convert this information into useful equivalents (Note: "~" means "approximately").

| Dimensions<br>(centimetres) | Area<br>(m <sup>2</sup> ) | Dimensions<br>(inches) | Area<br>(ft <sup>2</sup> or yd <sup>2</sup> ) |
|-----------------------------|---------------------------|------------------------|-----------------------------------------------|
| 100 x 100 cm                | = 1 m <sup>2</sup>        | ~ 40 x 40 inches       | ~ (over) 1 yd <sup>2</sup>                    |
| 30 x 30 cm                  | ~ 0.1 m <sup>2</sup>      | ~ 12 x 12 inches       | = 1 ft <sup>2</sup>                           |
| 15 x 15 cm                  | = 0.025 m <sup>2</sup>    | ~ 6 x 6 inches         | = 0.1 yd <sup>2</sup>                         |

Golf cup cutter plug: 11 cm in diameter ~ 0.01 m<sup>2</sup> (4.25 inches in diameter ~ 0.1 ft<sup>2</sup>)

**Which Method:** The choice of monitoring method depends on the site, the user and the suspected pest problem. For example, soap drenches work well to drive out active larvae, but not white grubs. Once a method is chosen, the same method should be used each time so that counts and averages can be compared from one year to the next.

**When and How Often:** The monitoring schedule depends on the category of the site and the life cycle of the problem insect. Intensive monitoring may be necessary for a few weeks in the spring for several species, but may not be necessary at other times of the year.



*Golf Cup Cutter*

• Top

### Action Decisions

On general use turf, in parks and other public facilities, injury levels depend on what the users will tolerate and how vigorously the turf is growing. On sports turf, safety considerations also influence treatment decisions because bare patches can increase the slipping hazard. Injury levels also

depend on the category of site. For example:

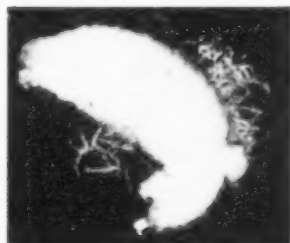
- Class A Sites: There is low tolerance for infestations of insects because of the potential for deterioration of playing surfaces, safety and aesthetic values.
- Class B Sites: Higher insect counts are tolerable unless their presence is attracting secondary pests, such as crows, ravens and raccoons to dig up the turf.
- Class C Sites: Generally insects are not a concern.

## Treatments

Insect populations in turf rarely reach levels that require treatment in most areas of BC, especially where turf is growing vigorously. Avoiding insecticide use in favour of improved cultural methods has the advantage of preserving the naturally occurring beneficial insects and mites that control pests.

## Biological Controls

Insect parasitic nematodes are the only type of biological control produced commercially at this time for turf pests. These are microscopic worms that move through the soil to attack insects (for more detailed information, see Chapter 3). Depending on the species of nematode available (it varies from year to year), they may be used for leatherjackets, white grubs, black turfgrass *Ataenius*, cutworms and other turf pests.



*Weevil Larva Attacked by Nematodes*

Nematodes are sold in a dormant stage, which is mixed in water and applied to the soil. They can also be applied through irrigation systems. They must be applied with sufficient water (at least 1.5 cm) to carry the nematodes down to the root zone where the pests are feeding. Irrigating both before and after applying nematodes has given better results than irrigation only after application.

**Note:** Nematodes are not active in cold soil conditions and most species are only effective when soil temperatures are above 12°C. Always consult suppliers for advice on which species to use and methods of application.

## Chemical Controls

Where possible, avoid broadcast or blanket applications of insecticides. These have been shown to reduce the natural populations of the beneficial insects and mites that eat the eggs and larvae of turf pests. Where possible, use spot treatments with selective insecticides. This reduces treatments costs and protects beneficial species.

If an insecticide treatment is judged necessary, make sure the product selected is:

- effective and registered for the specific insect,
- applied as a spot treatment instead of broadcast application wherever possible, and
- applied at the right time to have the greatest effect on target species. For example, timing pesticide applications for larval control is critical and must be determined by monitoring, since chemical treatments are more effective when larvae are actively feeding in the root zone.

For more precautions and guidelines for using pesticides in landscapes, see Chapter 11.

[Top](#)

## Evaluation

At the appropriate interval after any type of treatment, use visual inspections or counting methods to assess the effect. Check problem areas the following season at the right time in the life cycle of the insects to look for damage or count populations.

Use this information, along with other monitoring records, observations from field staff, feedback from clients, budget records, etc. to assess the effectiveness of the turf IPM program and find ways to improve it for next year.

## IPM Examples

Following are descriptions of four common turf pests with notes on monitoring, action decisions and treatments that could be incorporated into an IPM program. In any IPM program, correct identification of the pests before taking action is critical, as is the evaluation step to determine how to improve the program in the future.

### EUROPEAN CRANEFLY (*Tipula paludosa*)

The larvae, or 'leatherjackets', of European cranefly are dull gray, legless, and up to 3 cm long when they reach full size. They feed in the top 2-3 cm of soil among the roots of grasses. In severe infestations their feeding leaves ragged brown patches in the turf.

The adult cranefly is a large (2.5 m long), two-winged insect with extremely long, fragile legs. The females lay eggs in turf in August-September and the tiny larvae feed for a month or two in the fall. At this stage, however, they are so small that they do very little damage. The larvae over winter in the soil, where many are killed by natural enemies and winter weather. Those that survive, start feeding again in early spring. They grow to full size by mid-June, then stop feeding for a few weeks and pupate in early July. The adults emerge in late August to September. Outbreaks of this species were severe in BC

15-20 years ago. Now damaging numbers are usually found only in highly managed or stressed turf (i.e., golf course greens).

Recently another species of cranefly, *Tipula oleracea*, has been identified in south coastal BC. The most noticeable difference is that adults appear in April and May. This species may have two generations a year, but the need for treatment is not known. Current recommendations are to manage them as for European cranefly.

## Monitoring

Three methods of monitoring for leatherjackets are:

- In early spring, drench 1 m<sup>2</sup> areas of sod that shows signs of damage, with soapy water or pyrethrins solution (see text box under Monitoring in this chapter). Count the leatherjackets that wiggle to the surface.
- In spring or fall, pull back measured sections of sod and pick through the soil and roots to count larvae and pupae.
- Soak sections of sod in a saturated solution of salt water. Count the larvae that float to the top. For all methods, take 5-10 samples per site and average the counts.

## Action Decisions

Example of injury levels used by turf managers for leatherjackets are:

- Class A Sites: 20-25 larvae/m<sup>2</sup> in spring
- Class B Sites: 50-100 larvae/m<sup>2</sup> in spring
- Class C Sites: over 100 larvae/m<sup>2</sup> in spring or 300 larvae/m<sup>2</sup> in fall (the higher level in the fall is acceptable because many larvae die over winter)

## Treatments

Control measures are directed toward the larval (leatherjacket) stage. Treatments must be made when they are actively feeding in the roots in October or from April to early June. Treatments applied at other times of year are not effective.

### Biological Control

Apply insect parasitic nematodes (*Steinernema feltiae*) in the fall or as soon as the soil warms in the spring. Nematode products vary, therefore follow label recommendations for release rates and methods.

### Chemical Control

Although not usually recommended for general use turf because of the long-term harm to beneficial insects and mites that control crane flies (and other pests), diazinon can be used for leatherjacket control where high larval counts justify treatment. Fall treatments are usually not usually recommended because so many leatherjackets die over winter that treatments may not be needed.

## WHITE GRUBS — MAY OR JUNE BEETLES (*Phyllophaga* spp.)

"White grubs" are the larvae of May or June beetles. The larvae are large (up to 3 cm long), "C"-shaped grubs with reddish brown heads. They feed on the roots of grasses. Common species take three years to develop, moving deeper in the soil for the winter and rising to the root zone again in the spring. Full-grown grubs burrow 20-25 cm below the surface during July to pupate. The adults stay there to spend the winter and emerge from the soil in the spring.

## Monitoring

Lift sections of damaged sod, up to 10 cm deep, and search through the roots. Count and record the number of grubs, then replace sod. Count larvae in May or early June, before they burrow deeply to pupate.

## Action Decisions

Examples of injury levels:

- In healthy, irrigated turf, average counts of up to 15 larvae/0.1 m<sup>2</sup>, in spring, may be acceptable.
- In stressed turf, average counts of 5-10 larvae/0.1 m<sup>2</sup> may require treatment.

## **Treatment**

### **Biological Control**

Some species of insect parasitic nematodes (e.g., *Steinernema carposapsae*, *Heterorhabditis glaseri*) have been shown to be effective in controlling white grubs. Apply nematodes after soil temperatures have warmed and use sufficient water to flush nematodes down into the root zone of the turf. Always check with suppliers for availability of species and methods of applications.

### **Chemical Control**

Spot treatments of pesticides where sampling had identified high populations may be sufficient because white grubs usually occur in patches. Diazinon products are registered for white grubs in turf.

[Top](#)

### **BLACK TURFGRASS ATAENIUS (*Ataenius spretulus*)**

The larvae of this small, 5 mm long beetle, are white grubs that feed on the roots of grasses. Damage appears as irregular dead patches in turf and can look like damage some turf diseases. The adult beetles overwinter in the soil and emerge in April and May. They are mainly a pest of golf courses and in BC have been found on courses in the Okanagan Valley.

## **Monitoring**

### **Visual Inspections**

- Look for adult beetles around outdoor lights, which strongly attracts them; check irrigation valve boxes, where beetles congregate in moist conditions.
- Inspect the top layer of turf, particularly following heavy irrigation when they are more visible.
- Inspect thatch in the fall, along the perimeters of greens, which is an area preferred by the beetles.

### **Counting Methods**

- Pour soapy water into a large, bottomless tin can, pressed into the turf (see text box) to drive larvae to the surface for counting.
- Use a golf course cup cutter or other tool to remove sod samples. Look for larvae at the point where the soil and thatch layer meet.

Counting the numbers of larvae in the soil can be done in the fall to anticipate the numbers likely to appear the following spring. Counts for larvae can also be started two weeks after the adult beetles are first found in visual inspections.

### **Action Decisions**

- Action levels used in Ontario are 30-40 larvae/0.1 m<sup>2</sup> (300-400 larvae/m<sup>2</sup>), especially if turf is under stress.

- Experience has shown that heavy damage occurs when there are 250-300 larvae/0.1m<sup>2</sup> (2500-3000 larvae m<sup>2</sup>).

### **Treatment**

To prevent spreading beetles to other areas, wash mowers and clean out clippings catcher to remove adult beetles (don't forget to kill the collected beetles).

### **Biological Control**

Research in California has found that some species of insect parasitic nematodes are effective against the larvae. Applications should be made as soon as the soil has warmed in the spring, before adults begin to emerge.

[Top](#)

### **SOD WEBWORMS or LAWN MOTHS (*Crambinus* spp.)**

Sod webworms are small, whitish caterpillars (6-19 mm long), covered with short bristles. They are the larvae of small, light brown moths, which lay eggs in the turf. The larvae live in short, silk-lined tunnels at the base of grass plants, where they feed at night, chewing off the leaf blades. Damage appears as small, dollar-sized circular patches of thin turf. The last generation of larvae spends the winter in these tunnels and starts feeding again in the spring.

### **Monitoring**

- Inspect turf closely for missing leaf blades and green pellets of caterpillar excrement. Probe deeply into the thatch for signs of webbing and for larvae in silken tubes.
- Drench a measured area of turf with soapy water to drive larvae out of their tubes and make them easier to see (see text box).
- Count the number of larvae in measured areas of sod in several sample sites.

### **Action Decisions**

- Healthy turf may support up to 2-3 larvae/0.1 m<sup>2</sup> (20-30 larvae/m<sup>2</sup>). High populations are usually temporary and turf can usually withstand high populations when it is growing vigorously.
- Stressed turf may be damaged by as few as 1 larvae/0.1 m<sup>2</sup>.

### **Treatment**

Reduce thatch if it is over 2 cm deep, as webworms prefer thick layers of thatch. Where sod webworms are a chronic problem, reseeding with endophytic grasses may be an option for long-term control.

### **Biological Control**

Some species of insect parasitic nematodes (e.g., *Steinernema carpocapsae*) have been found to



control larval stages of sod webworm.

### Chemical Control

Treatment is usually not necessary, however, both diazinon and carbaryl are registered for sod webworms.

• Top

### Further Reading

Anon. 1987. Scott's Guide to the Identification of Turfgrass Diseases and Insects. O M. Scott & Sons. Marysville, Ohio 43041.

Leslie, A. R. 1989. Handbook of Integrated Pest Management for Turf and Ornamentals. Lewis Publishers, Boca Raton. 660 pp.

MacDonald, L. and H. Gerber. 1996. Turfgrass Disease and Pest Management Guide for Professional Turfgrass Managers in B.C. BC Ministry of Agriculture, Food and Fisheries. 80 pp. (From: Western Canada Turfgrass Association, 22097 Isaac Crescent, Maple Ridge, BC V2X 0V9. Tel: 604-467-2564)

Olkowski, W., S. Daar, H. Olkowski, 1991. Common-Sense Pest Control. The Taunton Press, Newtown, CT. (From: Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707. Tel: 510-524-2567 Web: <http://www.birc.org/>)

• Top

### Study Questions

1. Name 3 things to look for during a visual inspection of turf for insect pests.
2. Soap drenches are most useful for monitoring what type of insects?
3. Insect parasitic nematodes:
  - a) are most active when soil temperatures are below 12C.
  - b) are sold in an active stage.
  - c) should not be applied through irrigation systems.
  - d) must be applied with enough water to carry them to the root zone.
4. Why should broadcast applications of insecticides for turf insects be avoided where possible?

Return to Table of Contents

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.





## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

#### Chapter 7— IPM for Diseases in Turf

##### *Learning Objectives*

When you have completed this lesson, you should be able to:

1. *Classify common types of turf sites into three categories according to maintenance level.*
2. *List five practices that help prevent fungal diseases in turf.*
3. *Know where to look for help in identifying turf diseases.*
4. *Describe visual inspection and counting methods used in monitoring turf diseases.*
5. *Describe the use of mowing and microbial soil amendments in managing turf diseases.*
6. *Describe two main groups of turf fungicides and list general guidelines for using fungicides to control turf diseases.*
7. *Describe the role of evaluation in an IPM program for turf diseases.*

##### *Introduction*

Nearly all turf diseases in BC turf are caused by fungi. Common diseases in BC are red thread (*Laetisaria fuciformis*), anthracnose (*Colletotrichum graminicola*), brown patch (*Rhizoctonia solani*), Pythium root rot (*Pythium* spp.), Fusarium patch (*Microdochium nivale*), Typhula snow molds (*Typhula* spp.), take-all patch (*Gaeumannomyces graminis*), as well as localized dry spot and fairy ring, leaf spots and rusts. Necrotic ring spot (*Leptosphaeria korrae*) occurs in parts of the BC interior. Most fungal disease problems occur in highly managed turf (such as golf greens), especially in coastal areas or in years with higher than normal rainfall.

Turf management, especially with respect to diagnosing and managing diseases on highly managed turf, is a complex, technical field. Therefore, this chapter is intended to provide the general framework of an IPM program for turf diseases. For more information, consult the references listed under Further Reading at the end of this chapter. In particular, anyone managing large areas of turf should get a copy of Turfgrass Disease and Pest Management Guide for Professional Turfgrass Managers in BC. In addition to identification keys and colour photographs, the guide includes management and treatment recommendations for over 35 turf diseases in BC conditions.

As described in Chapter 2, using a system for categorizing sites according to maintenance level can help in planning an IPM program.

## Facility Categories

Examples of turfgrass sites that might be included in each category include:

- Class A - High level of service: fine ornamental lawns, golf and lawn bowling greens, irrigated sports fields.
- Class B - Moderate level of service: general park areas, residential and commercial lawns, boulevards, recreational fields, golf fairways.
- Class C - Low level of service: meadows, picnic areas, rough grass, undeveloped and naturalized areas.

The following section describes the general steps in an IPM program for turf diseases and gives examples of techniques currently available to turf managers. Given the number of different diseases that may occur, however, this is general information, intended only as a starting point.

[Top](#)

## Prevention

Prevention is the main approach to managing turf diseases. Before any disease can occur, three elements must be present: a susceptible plant, the disease agent (called a pathogen) and favourable environmental conditions for development and spread of the pathogen. If any parts of this "disease triangle" are missing, disease does not develop, therefore prevention of turf diseases is based on removing one or more of these elements.

Prevention for all turf pests involves using optimum site design and management. When designing and planting turf areas, plan for long-term disease management by starting with the correct drainage, soil preparation and choice of turfgrass cultivars adapted to the conditions. Follow this with turf management practices that ensure healthy, vigorous turf (see Chapter 5 for more management methods that contribute to healthy turf).

Conditions that predispose turf to most fungal infections include overly lush growth (i.e., from over-watering or over-fertilizing with quick-release nitrogen) and prolonged periods of leaf wetness (i.e., through natural weather conditions or poor irrigation practices). Other contributing factors are: mowing too short, compacted or poorly drained soils, temperature stress (too hot or cold for the type of grasses), drought or waterlogged conditions, under- or over-watering and nutrient deficiencies and imbalances.

Specific preventative practices for turf diseases (also called "cultural controls" in some references) are:

### a) Reduce periods of leaf wetness.

- Reduce the time dew spends on leaves. "Dew" on turf includes guttation water, which leaks out of grass blades, carrying with it sugars and other nutrients. This gives fungi a food supply and also allows the pathogens to move on a film of water to nearby plants. Sweep or drag light hoses or poles across the turf to disperse dew early in the day or irrigate for a short period early in the morning (i.e., for 2-3 minutes, 2 hours after sunrise) to dilute and wash off the nutrient rich dew.
- Time irrigation for early morning, rather than evening, to allow leaves time to dry thoroughly during the day. Use manual overrides on automatic watering systems so they can be readily adjusted to avoid overwatering in wet weather or use automatic rain delays to shut off irrigation in rainy weather.
- Prune nearby trees and shrubs to reduce shade and increase air movement across the turf,

which will speed drying of the leaf blades.

b) Plant disease resistant turfgrasses.

Some species and cultivars of grasses are tolerant of, or resistant to, some diseases. Planting mixtures of species and cultivars, rather than monocultures, helps slow the course of infections and reduces the chance that plants will be infected. Where the same diseases are a serious problem every year, renovating or overseeding with particularly resistant grasses may be advisable. Contact seed suppliers for local recommendations.

c) Use correct mowing practices

Mow at the correct height for the turfgrass species. Keep all mower blades sharp to reduce bruising and tearing of leaves that open the way for fungal attack.

- Avoid cutting turf when blades are wet as this increases the probability of spreading diseases.
- Clean clippings from the underside of mowers between jobs to reduce spread of disease.
- Allow turf to grow longer before the dry summer season or when a disease is observed. This depends on the disease, as some leaf diseases, such as red thread, can be managed by mowing, which removes the infection.



d) Manage traffic on turf.

Schedule maintenance procedures to avoid working in weather and turf conditions that favour the spread of diseases. Manage use of playing fields and sports greens to reduce damage and excessive wear, especially during wet, cool weather.

e) Remove snow and ice.

To reduce diseases caused by snow moulds, turf can be protected with snow blankets or straw mulches. Some managers apply peat, soot, well-aged manure or a dark-coloured fertilizer (e.g., Milorganite®) to speed melting of snow and ice. Ice can also be broken up with some types of aeration equipment.

• Top

## identification



Correct identification of diseases is essential because management methods must be tailored to fit the pathogen. Diseases are often difficult to diagnose because different diseases have similar symptoms. Also, symptoms may be mistaken for injury caused by poor growing conditions or physical damage. Diseases with similar symptoms may need to be positively identified by a plant pathologist.

To aid in diagnosing the problem, knowledge of the weather conditions in the preceding weeks is usually critical. See MacDonald & Gerber (1996) (under Further Reading at the end of this chapter), for a key to diagnosing turfgrass diseases based on recent weather and readily visible symptoms.

Other important factors are:

- when and what kind of fertilizer or soil amendments have been used
- irrigation amounts and timing
- whether pesticides (including fungicides) have been used, what products and when
- wear and use patterns
- physical characteristics of the site, such as low-lying areas, north side of slope, etc.

Accurate diagnosis usually requires careful collection of affected turf roots, stems, leaves and crowns and the use of a microscope or hand lens. The plant material must be taken from the area where the pathogen is still active. This is important because fungi found in dead turf may be decomposers and not the pathogen that killed the plant. The area of active infection is usually in the zone of turf between healthy and diseased plants, such as at the edges of patches, rings or spots. Carefully separate individual plants and tease out the roots to try to determine which part of the plant is affected (i.e., roots, crown, leaves). Rinse roots in water to check whether they are white and healthy or yellow, brown or rotted. Some leaf diseases may be secondary problems on turf that has a root disease or is growing poorly due to other factors.

Check soil in the root zone for a "black layer" (caused by lack of oxygen due to compaction and poor drainage) or a "dry layer" (water does not penetrate to the root zone).

Compare with photographs in identification guides using:

- signs of the disease, such as fruiting bodies, spores, mycelium
- symptoms of disease, such as wilting, colour of leaf, leaf spots, shape, colour and size of affected patches

Identification resources include:

- reference books, plant guides (suggestions are listed at the end of the chapter)
- resources on the internet
- staff at garden centres, community colleges, botanical gardens
- professional diagnostic services

**Note:** Professional services and companies can send samples to the provincial Plant Diagnostic Laboratory, Ministry of Agriculture, Food and Fisheries, 1767 Angus Campbell Road, Abbotsford, B.C. V3G 2M3. Phone: 604-556-3126 (there is a charge for this service). Contact the laboratory for specific instructions on how to collect and package turf samples to ensure that active disease organisms are present. When sending samples to a lab provide as much background information as possible about weather conditions, turfgrass species, cultivars, any pesticide use, fertilizing, irrigation and other management practices.

To help with future disease identification, it is a good idea to keep photographs and descriptions of disease symptoms that occur on various sites.



• Top

## Monitoring

Monitoring for turf diseases starts with keeping records of weather conditions, such as temperature, rainfall, relative humidity and light levels. Inspections for diseases should be conducted during the



seasons and the periods of weather that favour disease development. It is a good idea to train all staff involved in managing turf to know what to look for and how to recognize early symptoms of the turfgrass diseases most likely to appear on the site. Monitoring methods for turf diseases include:

### Visual Inspections

- Walk over the turf areas, noting damaged areas and symptoms of damage, such as shape, colour, size of patches and where the damage is in relation to soil or other conditions (shade, waterlogged or dry areas, etc.). Record information on a map for future reference.
- Use a hand lens for close visual inspection and a soil probe or knife to search deep in the thatch layer and root zone. Inspect turf leaf blades under a hand lens or magnifying glass to detect early signs of disease. Check roots as described under Identification (above).

### Counting Methods

- Carefully collect a pre-determined number of leaf blades (e.g., 30-40 blades). Count the number of blades with disease symptoms, such as spots, reddish coloured streaks or other discolourations. Determine what percentage of the total number of leaves collected are diseased.
- Measure the width of active disease rings to use as indicator of how fast the disease is spreading. It can be useful to mark the boundary of diseased areas to show changes over time.
- Count the number of disease patches in transects or grids using the same methods described for weed monitoring (see Chapter 5).

It is important to keep written records of all counts, as well as notes, photographs and maps of damage found during visual inspections for future reference.

**When and How Often:** The monitoring schedule depends on the category of the site, on how susceptible the turfgrass is to diseases, and on weather conditions, which are critical in influencing the growth of fungi. Monitoring carefully and often during expected infection periods makes it possible to catch disease infections early. For example, on highly managed turf (i.e., Class A sites) monitoring several times a week, or even daily, may be necessary during damp weather, but would be done less often at other times of the year. Familiarity with past disease problems on specific sites will help you in planning when and what to look for in the current year.

Class C turf may not require any monitoring as disease is seldom a problem on this type of site.

[Top](#)

### Action Decisions

How much injury from fungal diseases is tolerable depends a great deal on the particular disease and the susceptibility of the turfgrass. It also depends on whether conditions favouring the disease are likely to continue (such as spring rains) or whether they are under the control of the turf manager (such as irrigation practices) and can be corrected quickly. The timing of treatment actions also depends on how the treatment affects the pathogen. For example, most fungicides work by preventing the pathogen from infecting healthy turf, rather than by killing the pathogen directly. This means that in high risk sites such fungicides would be used when there is a sound basis for expecting infection to occur. Injury levels also depend on the category of site. For example:

**Class A Sites:** There is usually low tolerance for disease due to potential for swift spread on highly managed turf.

**Class B Sites:** Some damage may be tolerable, especially if turf is likely to recover with good management, a change in irrigation practices, or if weather is expected to change to conditions unfavourable to the pathogen.

**Class C Sites:** Generally, turf diseases are not a concern.

[Top](#)

## Treatments

Although fungicides have been the most common treatment for most diseases, not all diseases can be controlled with fungicides. A few other controls are available, such as mowing as a mechanical control for red thread and biological control products that show promise for suppressing other pathogens.

### Mechanical Controls

**Mowing:** Red thread (*Laetisaria fuciformis*) is a leaf pathogen that takes 10-14 days to develop after the grass is infected. Regular mowing (and removal of the clippings) during the period the pathogen is active can control it by removing the infected leaf blades before the disease develops. Recommendations for managing red thread usually include increasing nitrogen applications if the turf is deficient in nitrogen. This helps the turf grow out of the infection with successive mowing.

### Biological Controls

Healthy soils, turf roots and thatch are home to many beneficial fungi, bacteria and other microorganisms that suppress pathogens in the soil. For example, take-all patch (*Gaeumannomyces graminis*) can be severe on newly established greens, but in 3-4 years symptoms are likely to disappear. It is thought this may be due to the build-up of disease suppressing microorganisms in the soil. These microorganisms may suppress pathogens by using up their food supply or making key nutrients unavailable. Others produce antibiotic compounds in the surrounding soil or may attack the pathogens directly. Researchers at Guelph are in the process of applying for registration for a promising product containing the fungus *Typhula phacorrhiza* for control of snow mold diseases caused by pathogenic *Typhula* spp.

Turf management practices that promote healthy conditions in the root zone also favour the native beneficial microorganisms. In contrast, broadcast applications of fungicides and other pesticides can wipe out these natural populations and leave turf open to infections. Research on ways to increase populations of beneficial microorganisms in turf has looked at using composts and commercial soil amendments containing beneficial organisms as a top dressing. For example, studies on control of brown patch (*Rhizoctonia solani*) and necrotic ring spot (*Leptosphaeria korrae*) have shown promising results using microbial amendments. This is an experimental area, however, and more work is needed to find out how well such products work under BC conditions.

### Chemical Controls

As a group, fungicides differ from other pesticides in that most do not kill the target pest. Most fungicides work by preventing spores from germinating or by stopping the fungi from growing. They are used to stop the spread of diseases by preventing new turf from being infected. Fungicides for turf can be divided into two main groups:

**Contact Fungicides:** These work by providing a protective shield over the surface of the leaf that prevents infection. The disadvantage is that they do not provide long-lasting protection because they

break down or wash away and are eventually mowed off as the grass grows.

**Systemic Fungicides:** These also provide a protective shield around the surface of the plant, but they are also absorbed into the plant and moved along to other tissues. They last longer than contact fungicides and provide protection from root and crown diseases that would not be reached with contact fungicides. The major drawback, however, has been the quick and widespread development of resistance to systemics as compared to contact fungicides. For example, resistance to the benzimidazole fungicides (e.g., benomyl, thiophanate methyl) can occur in dollar spot (*Sclerotinia homoeocarpa*) after just two or three seasons of use.

### Managing Fungicide Resistance

Development of fungi with tolerance or resistance to fungicides is an increasing problem. Although the most serious problems have been with resistant strains of dollar spot, which is not (yet) a common problem in BC, the potential for developing resistance is present for other pathogens. Overuse of fungicides contributes to this problem. Popular strategies for managing fungicide resistance, including using higher application rates and more frequent applications have not been shown to be effective. In some cases, combining systemic and contact fungicides or alternating fungicides with different modes of action may delay resistance. Results have not been consistent, however, and more research is needed.

To delay or avoid the development of resistance, it is essential to use preventative (cultural) methods as much as possible and to only use fungicides when monitoring shows they are necessary, rather than routinely.

### Choosing Fungicides

It cannot be emphasized enough that it is essential to correctly identify the disease to be able to choose effective fungicides. This is because modes of action and effects on fungi vary. Choosing the wrong fungicide may make matters worse. For example, using benomyl may increase the levels of *Pythium* infections rather than help control it. If a fungicide treatment is required, select the product according to the following guidelines. Make sure the product selected is:

- effective and registered for the specific pathogen
- chosen to minimize the risk of developing pesticide resistance
- chosen to minimize the risk of damaging the turf or increasing infections from another pathogen
- applied at the right time to provide protection or have the greatest effect on target species
- applied only to those areas requiring treatment to limit the damage to disease suppressing micro-organisms in the soil

When an infection occurs that must be treated, the manager should re-evaluate the management program for the site to determine how to improve turf health and how to prevent the disease in the future.

For more precautions and guidelines for using pesticides in landscapes, see Chapter 11.

• [Top](#)

### Evaluation

At suitable intervals after any type of treatment, use visual inspections or counting methods to assess the effect. Follow-up inspections include checking for:

- reduction or elimination of disease symptoms
- restoration of turf to normal vigour

Use this information, along with other monitoring records, observations from field staff, feedback from clients, budget records, etc. to assess the effectiveness of the turf IPM program and find ways to improve it for next year.

### Further Reading

Anon. 1987. Scott's Guide to the Identification of Turfgrass Diseases and Insects. 1987. O.M. Scott & Sons. Marysville, Ohio 43041.

Leslie, A. R. 1989. Handbook of Integrated Pest Management for Turf and Ornamentals. Lewis Publishers, Boca Raton. 660 pp. MacDonald, L. and H. Gerber. 1996. Turfgrass Disease and Pest Management Guide for Professional Turfgrass Managers in B.C. BC Ministry of Agriculture & Food. 80 pp. (From: Western Canada Turfgrass Association, 22097 Isaac Crescent, Maple Ridge, BC V2X 0V9. Tel: 604-467-2564) Olkowski, W., S. Daar, H. Olkowski, 1991. Common-Sense Pest Control. The Taunton Press, Newtown, CT. (From: Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707. Tel: 510-524-2567 Web: <http://www.birc.org/>)

Vargas, Jr., J. M. 1994. Management of Turfgrass Diseases. 2nd Ed. CRC Press, Boca Raton, Florida. 294 pp.

• Top

### Study Questions

1. For each statement in Column A, choose the best match from Column B:

#### Column A

- \_\_\_\_\_ fungi
- \_\_\_\_\_ disease triangle
- \_\_\_\_\_ mowing
- \_\_\_\_\_ Class C sites
- \_\_\_\_\_ prevention

#### Column B

- a. susceptible plant, pathogen, favourable environment
- b. turf disease is usually not a concern
- c. cause most turf diseases
- d. delays or avoids development
- e. mechanical control for red thread

2. Why is it important to reduce the amount of time dew spends on turf leaves?

3. Why are turf diseases often difficult to diagnose?

4. For turf diseases, when and how often to monitor depends on what three factors?

5. List the two main groups of turf fungicides and state one disadvantage of each.

[Return to Table of Contents](#)

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.





## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

#### Chapter 8 — IPM for Insects & Mites in Greenhouses & Nurseries

##### *Learning Objectives*

When you have completed this lesson, you should be able to:

1. *Classify greenhouse and nursery facilities into two categories according to maintenance level.*
2. *List five methods that prevent insect (and mite) problems in such facilities.*
3. *Know where to look for help in identifying pests.*
4. *Describe three general monitoring methods used in greenhouses and nurseries.*
5. *Describe the use of biological controls and physical / mechanical controls in greenhouses and nurseries.*
6. *List general guidelines for using insecticides to control greenhouse and nursery insects.*
7. *Describe the role of evaluation in an IPM program for pests in greenhouses and nurseries.*
8. *Describe monitoring methods, give examples of treatment thresholds and treatments for aphids, greenhouse whitefly, black vine weevil and spider mites.*

##### *Introduction*

This chapter describes IPM for pests found in conservatories, propagating greenhouses and nurseries, indoor plantings in offices and public buildings and other interior plantscapes. Common pests in such planting are black vine weevil (*Otiorhynchus sulcatus*) and various species of whiteflies, thrips, spider mites, fungus gnats (*Bradysia* spp.), aphids, mealybugs and scales.

As described in Chapter 2, using a system for categorizing sites according to maintenance level can help in planning an IPM program. As interior plantscapes and plant nurseries are generally all high value or high maintenance sites they may be divisible into only two main classes.

##### *Facility Categories*

Examples of facilities that might be included in each category include:

- Class A - Highest level of service: e.g., conservatories, interior display gardens, hanging



baskets, plants in offices and malls.

- Class B - Moderate to high level of service: e.g., propagation benches in greenhouses, outdoor nurseries for planting stock.

The following section describes the general steps in an IPM program for indoor plant and nursery insects (and mites). It also gives examples of treatments and management techniques currently available. Outlines of IPM programs for four common pests are included at the end of the chapter. This information is intended as a starting point, to be adapted to suit specific sites and improved as new products and methods are developed.

• Top

## Prevention

The elements of prevention (also called "cultural controls" in some references) for greenhouse and nursery pests involve using optimum site design and management. When designing and planting conservatory beds and other display areas, plan for long-term insect management by starting with the correct drainage, soil preparation and fertility. Select plants suited to the light levels and other environmental conditions. Follow this with management practices that keep plants healthy, including providing good air circulation and ventilation to lower the temperatures in sunny conditions, measures to raise humidity in dry conditions, as well as pruning, thinning and staking as appropriate.

Additional preventative practices include:

### a) Choose pest resistant plants:

Choose plants that are poor hosts for common greenhouse and nursery pests. For example, lantana, hibiscus, geraniums, fuchsia, Poinsettias and Jerusalem cherry are preferred hosts for greenhouse whitefly (*Trialeurodes vaporariorum*), whereas most waxy leaved foliage plants are not. In conservatories and other interior plantscapes, plants with chronic pest problems are easy to find. A long-term pest management plan would include replacing them with less susceptible species if possible.

### b) Avoid importing pests:

The majority of indoor plant pests do not come from outdoor plants. They are spread on infested plants from other greenhouses and nurseries. To avoid bringing new pests into a facility:

- Inspect all planting stock before purchase or delivery. Check roots as well as foliage, to ensure plants are not bringing in new or exotic pests.
- "Quarantine" new shipments of plants. Some managers set aside a separate greenhouse or holding room, where new stock is kept away from established plants for several weeks, until it is known whether they are carrying pests. If necessary, the new plants can be treated before they are moved into the main greenhouse or nursery.
- Segregate stock plants from young plants to prevent spread of pests.
- Grow bedding plants from seed.
- Use non-soil mixes or pasteurized soil mixes for nursery stock and bedding plants to avoid soil-borne insects.

### c) Keep pests out:

A few species, such as western flower thrips and aphids are common on outdoor plants and can fly into greenhouses through vents. To prevent this:

- Screen all vent openings and fan intakes. Window screen mesh will keep out moths, aphids and other species. Extremely fine mesh or micro-pore screen is required to keep out thrips. Such fine mesh reduces the air flow through the vent, usually to 20-25% of the flow through an unscreened opening. This means that the surface area of vents must be increased accordingly to allow the right amount of ventilation.

• Top

---

## Identification

Correct identification of insect and mite pests is essential because monitoring and treatment methods must be tailored to a particular species. Once a problem species is identified, then information about its life cycle can be used to pinpoint when treatments will have the greatest effect and what preventative measures would be most effective.

If you suspect an insect problem, inspect damaged leaves carefully, under magnification. A 10-15 X hand lens is useful for this, while using a binocular dissecting microscope is even better. This is because many greenhouse and nursery plant pests are extremely small and hard to see. Experienced pest managers can often identify indoor pests based on the characteristic appearance of leaf damage, however, it is always a good idea to search until the damaging insects or mites are found. This is especially important if biological controls are to be used (described below), because some only attack particular species.

To identify insects and mites, use:

- reference books, insect guides (listed at the end of this chapter)
- resources on the internet
- staff at garden centres, community colleges, botanical gardens
- professional diagnostic services

Note: Professional services and companies can send samples to the provincial Plant Diagnostic Laboratory, Ministry of Agriculture, Food and Fisheries, 1767 Angus Campbell Road, Abbotsford, B.C. V3G 2M3. Phone: 604-556-3126 (there is a charge for this service).

Tips on preserving insect samples for identification include:

- Put large, adult insects in a freezer to kill them, then allow the specimens to dry in the air. Store them in vials or small boxes. It is easier to handle specimens for future reference if they are mounted on a pin. Insert the pin as soon as the specimen thaws from the freezer, before it dries out.
- Preserve tiny insects, mites and soft-bodied larvae in small, tightly sealed vials of rubbing alcohol. Use a fine paintbrush to pick up the specimens. The colours fade in alcohol, therefore make a note of the natural colour of the live specimen to help in identification.
- Label all specimens in pencil with location, date, host plant and your name.

• Top

---

## Monitoring

Examples of common monitoring methods for greenhouse and nursery pests are:

### Visual Inspections

Regularly, usually weekly, inspect a representative sample of plants. Use a 10-15 X hand lens or headband magnifier to get a close look.

- Check the undersides of leaves, growing tips and lower leaves, along stems, leaf veins and in axils of leaves.
- Look for curled, twisted, rolled or discoloured leaves and buds.
- Look for webbing and yellowish "stippling" (speckled appearance) on leaves that would indicate spider mites.
- Look for sticky patches of honeydew that would indicate sucking insects on the foliage above.
- Check for larvae around crown of plants susceptible to root weevils.
- Slide nursery stock out of pots to check the root ball for larvae, especially where weevil damage appears on leaves (small notches in the leaf margins).

### Indicator Plants

Where many different kinds of plants are grown, as in conservatories, using indicator plants can reduce the time spent monitoring. These are plants you would check first because they are most attractive to particular pests. As long as these plants stay pest-free, there is likely no need for other plants to be checked. If pests are found on the indicator plants, then other plants over a wider area should be inspected. To use indicator plants with confidence, you must know what pests to expect and which plants in the conservatory are likely to be the most susceptible to them. Examples of indicator plants are:

- for spider mites: palms, Easter lily, dieffenbachia, citrus
- for greenhouse whitefly: poinsettias, hibiscus, lantana, Jerusalem cherry, fuchsia

### Sticky Traps

Yellow sticky traps are used to monitor for whiteflies, fungus gnats, thrips and certain species of leaf miners. Blue sticky traps are also used to monitor for western flower thrips.

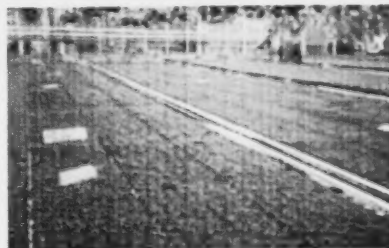
Tips for using traps include:

- Hang traps as soon as seedlings, plugs or transplants are put on benches. Place traps among nursery stock outdoors as soon as weather warms in early spring.
- Hang traps level with, or just below, the tops of plants to catch whiteflies. Place them 20-30 cm above the level of the soil or greenhouse bench to catch fungus gnats.
- Use enough traps to give a representative sample from the area. Usual rates are 1 sticky trap/50-200 m<sup>2</sup> or 1 trap/50 plants. Use the higher densities of traps to pinpoint infestations more accurately.
- Inspect traps weekly and count the insects caught. Replace traps after 3-4 weeks (indoors) or 2 weeks (outdoors) or more often if they become loaded with insects, dust or debris.

It is important to keep written records of all counts, as well as notes and maps of damage from visual inspections for future reference.

For a summary of monitoring methods to use in greenhouses and field nurseries, see tables included in the Nursery and Landscape Pest Management and Production Guide (see Further Reading). For more information on monitoring indoor pests in plantscapes and conservatories, see other references listed at the end of the chapter.

*Greenhouse*



*Sticky Traps in a*

### When and How Often

The monitoring schedule depends on the life cycle of the problem insects or mites and on the time of year. Although most indoor plant pests may be present year around, they usually reproduce more slowly in the winter. A month-by-month timetable for monitoring common greenhouse and nursery pests in BC is included in the Nursery and Landscape Pest Management and Production Guide.

• Top

### Action Decisions

In conservatories and other public facilities, the injury level often depends on how much damage the public will tolerate, rather than on the direct harm a pest might be causing to a plant or to a site. In propagation and nursery areas, the injury level may depend on whether the pest is likely to spread to other stock and what effect it could have on the growth rate or long-term health of the plant. The injury level can also vary with the age of the plants. For example, more damage may be tolerable early in a propagation cycle, when plants have time to replace damaged leaves, than would be acceptable for plants ready to sell.

Injury levels also depend on the category of site. For example:

- Class A Sites: There is usually a very low tolerance for infestations of insects because of high visibility and aesthetic value of plantings.
- Class B Sites: Low levels of infestations may be more tolerable, especially in plants where "clean-up" sprays can be used before plants move to sales or planting sites.

The action level depends on what type of control is planned. If biological controls are to be used, releases usually start after pest populations are present, but at very low levels. Examples of action levels used by greenhouse managers are:

#### Greenhouse whitefly (*Trialeurodes vaporariorum*):

- 1 whitefly/10 traps, or 1 whitefly found on any trap, to begin releases of *Encarsia* parasitic wasps.
- 5 whiteflies/trap/week to apply a pesticide

#### Thrips (*Thrips tabaci*, *Frankliniella occidentalis*):

- 1 thrips on any trap may be used as an action level for low release rates of the predatory mite *Amblyseius cucumens*.
- 3-4 thrips/trap /week for higher releases rates of predators or applying a pesticide.

#### Aphids (various species):

- When one or more aphid colonies is found, begin releases of biological controls.

Action levels for treating aphids can be higher in bedding plants and nursery stock about to be planted out because there are usually enough native aphid predators present outdoors to control aphids.

• Top

## Treatments

When a pest problem occurs that must be treated, the manager should re-evaluate the management program to determine how to prevent the problem in the future.

## Cultural Controls

In addition to methods that produce healthy plants, sanitation methods are important cultural controls in greenhouses and nurseries.

Sanitation — Ways to remove pest breeding sites include:

- Control weeds both in, and around, greenhouses and nurseries as they can be alternate hosts for whiteflies, aphids and other pests. Remove weeds under benches, in nursery pots and planting beds.
- Maintain at least a 3-m wide, closely mowed strip around the outside perimeter of production greenhouses and nurseries to remove host plants for thrips, aphids, tarnished plant bugs, etc.
- Drain all wet spots in greenhouses benches, floors and between nursery rows to remove breeding sites for fungus gnats and shore flies. Correct any problems with irrigation systems in benches and beds that cause some areas to be over watered.

## Biological Controls

Many species of natural enemies are now sold commercially to control common pests in greenhouse and conservatories. Relatively high release rates may be needed to provide acceptable control on ornamentals. In general, the biological controls should be released as soon as monitoring shows target pests are present at low levels. Before placing an order, always consult the supplier of biological controls to make sure you order the right species and know how to use them. Suppliers can provide monitoring and release rate information as well as tips on timing releases, providing alternate food or water sources and adjusting temperatures to get the best results from their products. See Chapter 3 for a table of biological controls available commercially.

Most predatory insects are not effective in offices or malls where plants are spaced far apart within a much larger building. This is because the adult insects become lost and often fly to windows (where people using the building may consider them a nuisance). Predatory mites, however, can be effective in such situations because they cannot fly and are more likely to remain on plants. They are also so small that people do not notice them.

## Physical and Mechanical Controls

Examples of physical and mechanical controls for indoor and nursery pests include:

- Yellow sticky traps used in large numbers (1 trap/plant) to catch adult whiteflies, fungus gnats (*Bradysia* spp.) and shore flies (*Ephydra* spp.).
- Strong sprays of water used to control aphids and some species of sawflies, such as roseslug and pearslug (*Endelomyia* spp.).
- Removing infested leaves by hand or pruning out infested branches to manage light infestations on a few plants; this is particularly useful for leaf miners.
- Hand-held vacuum cleaners used to remove adult whiteflies from the top foliage of plants.

## Chemical Controls

Fewer chemicals are registered for use indoors than are available for outdoor use. Nowhere is the use of highly toxic and persistent chemicals less advisable than in interior plantscapes, malls and office areas frequented by the public. Least-toxic, 'preferred', products are recommended because:

- it is usually difficult to keep people out of such sites long enough to ensure sufficient ventilation after an application, and
- commercially available biological control agents are effective for many indoor pests, but most cannot be used while pesticide residues are present on plants.

Preferred insecticides are described in more detail in Chapter 3. Those of most use in interior plantscapes include:

- insect growth regulator, kinoprene (e.g., Enstar®), for aphids and whiteflies on ornamentals
- *Bacillus thuringiensis kurstaki* for various species of caterpillars
- insecticidal soaps for chewing and sucking insects and spider mites
- pyrethrins for thrips, aphids and flying insects
- horticultural (summer) oils for scale, mites, aphids and whiteflies

Regularly scheduled, broadcast spraying is usually not recommended because aphids, thrips and spider mite populations in greenhouses commonly develop resistance to routinely used pesticides. Western flower thrips populations that are resistant to pesticides are now wide-spread in the horticulture industry.

There are times when broadcast sprays may be appropriate as a "clean-up", such as:

- When pest populations are too high to successfully start a biological control program, least-toxic, non-residual products can be used to reduce pest populations before releasing biological controls.
- Before bedding plants or nursery stock are sold or shipped to retailers they might be treated to remove insects (both pests and beneficial species, if their presence is a concern).

If an insecticide treatment is judged necessary, select the product according to the following guidelines. Make sure the product selected is:

- effective and registered for the specific insects or mites and for indoor use, if required
- applied as a spot treatment instead of broadcast application wherever possible (see exceptions above)
- applied at the right time to have the greatest effect on target species. For example, timing pesticide applications to control scale would be determined by monitoring for presence of the mobile nymph, which is the stage most susceptible to pesticides.
- compatible with use of biological controls, if these will be used (lists of compatible pesticides are available from biological control suppliers).

For more precautions and guidelines for using pesticides in landscapes, see Chapter 11.

• [Top](#)

## Evaluation

After any type of treatment, monitor, using visual inspections, sticky trap monitoring and other methods to assess the effects on the pest population. To determine the progress of biological control programs it may be necessary to do follow-up monitoring for a month or more.



Use this information, along with other monitoring records, observations from field staff, feedback from clients, budget records, etc. to assess the effectiveness of the IPM program and find ways to improve it for next year.

## IPM Examples

Following are descriptions of four common pests in greenhouses or nurseries, with notes on monitoring, action decisions and treatments that could be incorporated into an IPM program. In any IPM program, correct identification of the pests before taking action is critical, as is the evaluation step to determine how to improve the program in the future.

### APHIDS



*Aphid Midge Larva  
Attacking an Aphid*

Aphids are small, pear-shaped sucking insects, 2-8 mm long, with long, backward projecting antennae. There are many species of aphids, but the most common one in greenhouses and conservatories is the green peach aphid (*Myzus persicae*). Other species common in nursery stock are the rose aphid (*Macrosiphum rosae*), potato aphid (*Macrosiphum euphorbiae*) and spruce aphid (*Elatobium abietinum*). Aphids suck plant sap, causing distorted foliage and buds and dropped leaves. They also excrete a sweet honeydew, which drips onto leaves and supports the growth of unsightly sooty moulds. On indoor plants green peach aphids can continue to reproduce all year around.

### Monitoring

Inspect plants weekly. Look for distorted, curled foliage and shiny drops of honeydew on leaves as an indicator of sucking insects. Use a 10-15 X hand lens to look for aphid colonies, concentrating on new growth and growing tips as well as on the undersides of oldest leaves.

### Action Decisions

Where biological controls will be used, the time to take action for releasing predators is usually as soon as aphid colonies are found during regular monitoring.

Timing of pesticide applications as a 'clean-up' for aphids on nursery stock may be most economical if done when stock is ready to be shipped to retail outlets.

### Treatments

#### Physical Control

Prune out heavily infested branches. For plants that can withstand it (and that are in a location that permits it), remove aphids by spraying the plants with a strong stream of water. It is only necessary to knock the aphids loose from the plants because this damages their mouthparts and prevents them from feeding again. Two or three sprays are usually sufficient to control aphids.



## Biological Control

Natural enemies of aphids sold for aphid control on indoor plants include the aphid midge (*Aphidoletes aphidimyza*), lady beetles (*Hippodamia convergens*, *Harmonia axyridis*) and several species of parasitic wasps (*Aphidius* spp.). In conservatories, biological controls for aphids can be very effective if they are introduced as soon as the first aphids are found. Using a combination of biological control species is often more effective than relying on one species. It may be necessary to control ants (using ant traps) in conservatories to stop the ants from protecting aphid colonies from predators.

On outdoor nursery plants, the aphid midge, *A. aphidimyza*, is likely to be the most effective predator for release. Generally, they should be released in the spring, 2 or 3 times at 7-10 day intervals to supplement the naturally occurring populations of aphid predators outdoors.

## Chemical Control

Aphids are hard to control with pesticides because spray coverage must be very thorough to reach aphids on undersides of leaves and in curled leaves. If any aphids survive they quickly generate a new colony. Aphid populations also readily become resistant to pesticides that are used often.

Insecticidal soap, pyrethrins, and horticultural oils can be used as spot sprays or to reduce aphid populations before releasing biological controls. The insect growth regulator, kinoprene, selectively controls aphids on greenhouse ornamentals. Heavy infestations in nursery stock may require treatment with diazinon or other registered pesticides as a last resort.

[Top](#)

## GREENHOUSE WHITEFLY (*Trialeurodes vaporariorum*)

Adult whiteflies are tiny (1 mm long), powdery white insects. The nymphs suck plant sap; they look like flattened, pale green or white scales on the undersides of leaves. Their feeding weakens plants and they excrete honeydew, which supports the growth of unsightly sooty moulds. Greenhouse whitefly does not overwinter outdoors in BC, therefore can only be spread between greenhouses on infested plants. Once present in an interior plantscape, it is difficult to eradicate, but biological controls can keep numbers below injury levels.

## Monitoring

- Hang yellow sticky traps in the plant canopy and count the adult whiteflies caught on traps weekly.
- Inspect indicator plants, such as lantana, hibiscus, poinsettia, Jerusalem cherry and fuchsia, which are highly susceptible to whiteflies.

## Action Decisions

- In mixed plantings, where only some plants are attractive to whitefly, a suggested action level for releasing the whitefly parasitic wasp *Encarsia formosa* is 1 whitefly/10 yellow sticky traps.
- Where plantings or greenhouse benches include a large number of plants susceptible to whitefly, *Encarsia* release would start when one whitefly is caught on any trap (always contact the biological control suppliers for their latest recommendations on release rates and timing).
- In nurseries where there is a history of whitefly problems, it may be most effective to release *Encarsia* weekly, at low rates, even before whiteflies are found on monitoring traps. Release

rates should be increased after whiteflies are detected.

## Treatments

### Biological Control

The parasitic wasp, *Encarsia formosa*, attacks whitefly nymphs. They turn from white to black as the parasite develops inside. *Encarsia* can eliminate whitefly from greenhouses in the summer, however, they are not as effective during cool weather and low light conditions of winter. Monitor progress by comparing counts of unparasitized whitefly nymphs (white) to parasitized nymphs (black). As a general rule, *Encarsia* releases should continue until over 80% of the nymphs have turned black. The small black lady beetle, *Delphastus catalinae* is a whitefly predator that can be released along with *Encarsia* as soon as whiteflies are present.

### Physical and Mechanical Control

Vacuum adult whiteflies from the top leaves of plants using a hand-held vacuum. Use high numbers of yellow sticky traps to physically remove adult whiteflies. Before releasing biological controls, prune out the worst infested foliage to reduce the whitefly population and make it easier for *Encarsia* to search the plants.

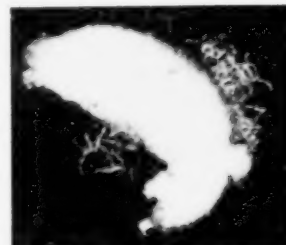
### Chemical Control

Chemical control of whiteflies is difficult because of the waxy coating on the nymphs. Before releasing *Encarsia*, reduce whitefly populations with insecticidal soap. After releasing *Encarsia*, spot spray new growth (where adult whiteflies congregate) with soap. The insect growth regulator, kinoprene, can be used to control immature whiteflies on greenhouse ornamentals.

• Top

## BLACK VINE WEEVIL (*Otiorhynchus sulcatus*)

Black vine weevils are common nursery pests in BC. They are dark grey beetles, 8 mm long, with a noticeable "snout". Adult weevils chew half-circle notches in the edges of leaves of rhododendron, azalea, yew and other ornamentals. The larvae are small, plump, white grubs that feed in the roots and crowns. Their feeding can stunt or kill plants.



Black Vine Weevil Larva  
Killed by Nematodes

## Monitoring

- Check leaves for signs of new notches from May onward, which would show that adults are present and will soon begin laying eggs.
- From June onward, slide nursery stock out of pots and look for larvae in soil cells around the outside of the root ball.

## Treatments

## Physical Control

Adult weevils come out to feed at night and can be knocked off of plants onto ground sheets and destroyed.

## Biological Control

Insect parasitic nematodes are effective at controlling the root weevil larvae in landscapes and nursery stock. Apply when weevil larvae are present in the soil (after July), water in well and keep soil continuously moist. Nematode products vary, so always follow product recommendations for timing and release rates.

## Chemical Control

Diazinon soil drenches are registered for control of larvae

• Top

## SPIDER MITES



The most common mite in interior landscapes is the two-spotted spider mite, *Tetranychus urticae*. It has a wide host range and becomes very damaging if left unchecked in hot, dry conditions. Spider mites suck plant sap, leaving stippled leaves. Some species spin silken webs. European red mite (*Panonychus ulmi*) occurs on nursery roses, ornamental apples, cherry and hawthorn. Citrus red mite (*Panonychus citri*) can occur in landscapes on citrus, palms, and other subtropical plants. In landscapes, spider mites are often worst on leaves in the warmest and driest conditions, such as the top of palms nearest the glass.

*Spider Mite*

## Monitoring

- Inspect leaves under 10-15 X magnification for webbing, stippling and mites.
- Tap twigs and branches to knock mites onto a sheet of white paper on a clipboard.

## Action Decisions

The predatory mite *Phytoseiulus persimilis* is most effective when applied at the first sign of a two-spotted mite infestation.

## Treatments

Mist plants and walkways frequently to raise humidity. This slows the feeding and reproduction of spider mites, while making conditions more favourable for predatory mites.

## Biological Control

Several species of predatory mites are sold commercially to control spider mites:

- *Phytoseiulus persimilis* is effective on two-spotted spider mites in greenhouses and protected cultures.
- *Galendromus* (= *Typhlodromus*) *occidentalis* is a hardy native predator mite that controls European red mite and citrus red mite. It does well under high or low temperatures and is more effective than *P. persimilis* in tree top foliage.
- *Amblyseius fallacis* is particularly effective on woody ornamental plants. An organophosphorous pesticide resistant strain is available from one BC supplier; it can be used where pesticides have been used to control other pests.  
The lady beetle *Stethorus punctillum* can also be used along with predatory mites for control of spider mites during the growing season.

## Chemical Control

Before releasing biological controls, spider mites populations can be reduced with sprays of insecticidal soap or fenbutatin oxide, which is compatible with predatory mites.

## Further Reading

\_\_\_\_\_. 1998. Nursery and Landscape Pest Management and Production Guide. BC Ministry of Agriculture, Food and Fisheries and BC Landscape & Nursery Association (From: BCLNA, Suite 101, 5880-176A St., Surrey, BC V3S 4E3. Tel: 604-574-7772)

Costello, R. A., D. P., Elliott, L. A. Gilkeson, & D. R. Gillespie. 1991. Integrated Control of Greenhouse Pests for Commercial Growers. BC Ministry of Agriculture, Food and Fisheries, Victoria. 19 pp. QP Stock #7610000832 (From: Queen's Printer, 2-563 Superior St., Victoria, BC V8W 9V7. Tel: (250) 387-3309, Fax: (250) 387-0388, Web: <http://www.bcsolutions.gov.bc.ca/qp/>)

Flint, M. L. and S. H. Dreistadt. 1998. Natural Enemies Handbook: The Illustrated Guide to Biological Pest Control. Pub. #3386. University of California. 154 pp. (From: ANR Publications, Univ. of Calif., 6701 San Pablo Ave., Oakland, CA 94608-1239. Tel: 800-994-8849 Web: <http://anrcatalog.ucdavis.edu/>)

Malais, M. & W.J. Ravensberg. 1992. Knowing and Recognizing: The Biology of Glasshouse Pests and Their Natural Enemies. Koppert Biological Systems, The Netherlands. 109 pp.

Matteoni, J. A. and D. Elliott. 2000. Applied Biological Control Manual: Greenhouse and Protected Crops. Applied Bio-Nomics Ltd. (From: ABN, 11074 W. Saanich Rd., Sidney, BC V8L 5P5. Tel: (250) 656-2123, Fax: (250) 656-3844, E-mail: [bug@islandnet.com](mailto:bug@islandnet.com))

Pascal, P. & W. Pirone. 1978. Diseases and Pests of Ornamental Plants. John Wiley and Sons, Toronto, Ontario. 546 pp.

Steiner, M.Y. & D.P. Elliott. 1987. Biological Pest Management for Interior Landscapes. Alberta Public Affairs Bureau, Edmonton, Alberta.

## Study Questions

1. Why is it advisable to inspect damaged leaves for insect problems using a hand lens or

dissecting microscope?

2. If you were visually inspecting plants, what pest problems would you suspect for each of the following symptoms:

- a) webbing and yellowish "stippling" on leaves
- b) sticky patches of honeydew
- c) small notches in the leaf margins

3. Injury levels for pests in greenhouse and nursery stock may depend on what? (Give 3 examples).

4. List 3 examples of how to remove pest breeding sites in greenhouses and nurseries.

5. What should you do before you place an order for biological controls?

6. Why is it not advisable to use highly toxic and persistent chemicals in interior plantscapes, malls and office areas frequented by the public? Give one reason.

[Return to Table of Contents](#)

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.





## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

#### Chapter 9 — IPM for Insects & Mites in Ornamentals & Trees

##### ***Learning Objectives***

When you have completed this lesson, you should be able to:

1. *Classify sites with ornamentals (including trees) into three categories according to maintenance level.*
2. *List five methods that prevent insect (and mite) problems in ornamentals.*
3. *Know where to look for help in identifying pests.*
3. *Know where to look for help in identifying pests.*
4. *Describe three general monitoring methods used for pests of ornamentals.*
5. *Describe the use of biological controls on ornamentals.*
6. *Give three examples of physical / mechanical controls used for ornamental pests.*
7. *List general guidelines for using insecticides and miticides on ornamentals.*
8. *Describe the role of evaluation in an IPM program for pests of ornamentals.*
9. *Describe monitoring, give examples of action levels and treatments for aphids, scale and tent caterpillars.*

##### ***Introduction***

This chapter describes pest management in trees, shrubs and ornamental plants in yards, gardens, parks and institution grounds, playgrounds, golf courses, boulevards and natural areas. Common pests in such plantings are various species of aphids, spider mites, scales, leaf-chewing caterpillars, root weevils, leafminers and borers. In parts of the south coast, winter moth (*Operophtera bruceata*) and jumping gall wasp (*Neuroterus saltatorius*) on Garry oak are local problems, while elm leaf beetle (*Pyrrhalta luteola*) and fall webworm (*Hyphantria cunea*) are common problems in the southern interior.

As described in Chapter 2, using a system for categorizing sites according to maintenance level can help in planning an IPM program.

##### **Facility Categories**



Examples of sites that might be included in each category include:

- Class A - High level of service: rose and specialty gardens, display areas of parks and boulevards, residential front yards, golf courses and institution grounds.
- Class B - Moderate level of service: plantings in neighbourhood parks, playgrounds, residential backyards, along boulevards.
- Class C - Low level of service: greenbelt areas, vacant municipal land, highway plantings; natural areas of yards and parks.

The following section describes the general steps in an IPM program for insects and gives examples of techniques currently available. Outlines of IPM programs for three common insect pests of ornamentals are also included. This information is intended as a starting point, to be adapted to suit specific sites and improved as new products and methods are developed.

• Top

## Prevention

Compared to natural growing conditions, urban environments tend to have higher temperatures, less air flow and more disturbed and compacted soils that reduce the supply of oxygen and water to plant roots. Winter road salt and air pollution from traffic exhaust also pose problems. With a careful choice of plants and efforts to correct poor conditions, it is possible to design healthy, pest-free landscapes even for difficult conditions. Unfortunately, however, it is all too common for plants to be chosen without considering whether they are suited to the site or are resistant to pest problems. Thus, boulevards are still being planted with pest susceptible *Prunus* and *Liriodendron* trees that saddle those responsible for maintaining them with future pest management costs. In the Okanagan region, for example, *Prunus* and *Malus* trees are prone to many pests that cause problems for landscapers and gardeners. They also harbour pests that can spread to nearby agricultural crops.



*Roses in Shade*

The elements of prevention (also called "cultural controls" in some references) for ornamental pests are:

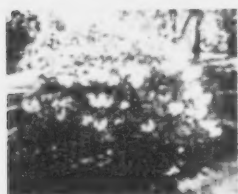
### a) Use optimum site design

- Ensure there is the right drainage, soil preparation, fertility and pH for the intended plants.
- Select plants suited to the sun exposure, soil type, drainage, climate and other environmental conditions. Consider growth habit and height of mature trees when choosing plantings under utility lines. The importance of choosing the right plants for the site cannot be overstated. Studies have shown that when trees adapted to the sun are planted in shade their resistance to pests and disease attack drops; when shade-adapted plants receive too much sun they also become more likely to be attacked.
- Choose a diversity of species and families of trees and shrubs. When there are many plants of the same species in an area, pest populations can build up to high levels.
- Select healthy, well-grown planting stock that has been fed and shaped appropriately for the type of plant. Inspect all planting stock before purchase or delivery and check roots as well as foliage, to avoid bringing in new or exotic pests.

### The 20-10 Planting Rule

A rule of thumb for ensuring diversity in a landscape is to choose no more than 20% of plants from any one family and no more than 10% from any genus. For example, 20% of shrubs and trees might come from the family *Rosaceae*, but no more than 10% from each genus, such as *Photinia*, *Pyracantha*, *Spiraea*, *Rubus*, *Malus*, etc.

#### b) Choose pest resistant plants



Weevil Resistant  
Rhododendron

Select cultivars that are most resistant to common pests. For example, plant rhododendron and azalea cultivars resistant to feeding by adult black vine weevils. A long-term pest management plan may include replacing the most susceptible plants with less susceptible species and cultivars wherever possible. This is particularly important for long-lived, woody plants because the total cost of managing pests on susceptible plants can be very high over the lifetime of the planting.

### Cypress Tip Moth? Think Resistance!

Cypress tip moth (*Argyresthia* spp.) attacks juniper (*Juniperus* spp.), arborvitae and cedars (*Thuja* spp.) and cypress (*Cupressus* spp.). On highly susceptible plants, such as American arborvitae (*Thuja occidentalis*), Pfitzer juniper (*J. chinensis* 'Pfitzerana') and *Chamaecyparis lawsoniana*, it can make an unsightly, brown-tipped mess of an evergreen hedge. Once the tip moth is established the only controls are annual spraying with residual insecticides when the moths are active or removing the hedge and starting over. It would be much better (and cheaper and easier) to avoid the problem by starting with resistant species, such as western red cedar (*Thuja plicata*), or by choosing a different family of plants altogether for the hedge.

#### c) Use planting practices that give plants the best start

- Set plants at the correct depth (usually the same level as in the nursery).
- Plant far enough from building foundations to allow for the mature size of plants.
- Remove turf from the planting area where plants are set in lawns and control weeds around trunks for the first 1-2 years.
- Dig generous planting holes to accommodate roots (don't forget to remove plastic pots or burlap root ball covers).
- Stake and protect trunks of young trees.

#### d) Follow management practices that keep plants healthy.

- Use fertilizing and watering practices suited to the site and the needs of the plants.
- Install irrigation systems that can accommodate the differences in water requirements between turf, shrubs and trees in the landscape. Ensure regular and adequate water during establishment of new plantings.
- Use correct pruning methods to speed wound healing and prevent insects and decay organisms from entering.
- Protect trees from injury by mowers, line trimmers, vehicles, construction equipment, etc. by

using barriers, trunk protectors, temporary fences or other measures. One way to cut down on mower injury to trees in turfed areas is to keep a circle of mulched or bare soil around the base of the trunks so that mowers do not need to work close to the tree.

### Keeping Up the Defense

Fertilizing and watering for healthy plants does not necessarily mean encouraging rapid or vigorous growth. While drought or nutrient stress can make trees more susceptible to borers and other pests, studies have consistently found that too much water and fertilizer also makes trees more susceptible to pests. The explanation lies in the fact that woody plants produce a range of chemicals in their tissues that help defend them against pests. Tannins in oaks and terpenes in pine, are examples of chemicals that are repellent to pests. When trees are growing rapidly, they have less of these defense chemicals in their tissues. Maintaining healthy trees and shrubs involves achieving a balance between growth and defense. This is a basic principle of the Plant Health Care Management System developed by the International Society of Arboriculture (for more information, see Further Reading at the end of this chapter).

• Top

### Identification

Due to the wide variety of trees and shrubs grown in BC, a landscape manager may encounter many different pests. Generally, they fall into four main groups:

- sucking insects and mites (e.g., aphids, scales, leafhoppers, spider mites)
- root / crown feeding insects (e.g., root weevils)
- leaf-eating insects (e.g., leaf miners, tent caterpillars, fall webworm, leafrollers)
- borers (e.g., shot-hole borer, bronze birch borer)

Correct identification is essential because monitoring and treatment methods must be tailored to a particular species. Some pests cause very similar damage, which can also be mistaken for diseases or disorders caused by poor growing conditions. Once a problem species is identified, then information about its life cycle can be used to pinpoint when treatments will have the greatest effect and what preventative measures would be most effective.

If you suspect an insect or mite problem, inspect damaged leaves and nearby shoots and branches, carefully, under magnification. Collect insects and samples of damaged plants to inspect under a microscope. If no suspects are visible on the damaged tissue, it may be because they are no longer present. This may be because larvae have left the plants to pupate or the pests might have been eaten by natural enemies. If this is the case, no further damage will show up in later inspections. If leaf damage continues, however, and no pests are found, it may be necessary to look for the pests at night, when nocturnal insects such as black vine weevils and cutworms come out to feed.

To identify insects and mites, use:

- reference books, insect guides (listed at the end of this chapter under Further Reading)
- resources on the internet
- staff at garden centres, community colleges, botanical gardens
- professional diagnostic services

Note: Professional services and companies can send samples to the provincial Plant Diagnostic

Laboratory, Ministry of Agriculture, Food and Fisheries, 1767 Angus Campbell Road, Abbotsford, B.C. V3G 2M3. Phone: 604-556-3126 (there is a charge for this service).

See Identification section in Chapter 8 for tips on preserving insect samples for identification.

• [Top](#)

## **Monitoring**

Monitoring provides the information needed to decide whether treatments are necessary, the best timing of treatments, and how the treatments are working. Most monitoring programs are based on regular inspection for pests, pest damage or other signs of their presence. It may also include monitoring for beneficial species. Examples of common monitoring methods for pests on ornamentals are:

### **Indicator Plants**

Using indicator plants can reduce the time spent monitoring. These are plants that should be checked first because they are most attractive to particular pests. As long as these plants remain pest-free, there is likely no need for other plants to be checked. To use indicator plants with confidence, a pest manager must know what pests to expect and which particular plants are usually attacked first.

### **Visual Inspections**

Regularly, usually weekly, inspect a representative sample of plants. Use a 10-15 X hand lens or headband magnifier to get a close look. Record observations.

- Check the undersides of leaves, growing tips and lower leaves, along stems, leaf veins and in axils of leaves.
- Look for curled, twisted, rolled or discoloured leaves and buds.
- Look for webbing and yellowish "stippling" (speckled appearance) on leaves that would indicate spider mites.
- Look for sticky patches of honeydew that would indicate sucking insects on the foliage above.
- Look for holes chewed in leaves and for signs of caterpillar droppings (frass).
- Check crowns of plants susceptible to root weevils for discolouration and damage.
- Look for fine shavings or sawdust on trunks or base of plants that would indicate borer activity.

### **Counting Methods**

The advantage of using counts in monitoring is that they give numerical (quantitative) measurements. If done carefully, these can be compared from year to year, regardless of who does the monitoring. The extra investment in labour to count and record pest populations can be well worth it for key pests in high value (Class A) sites. It may not be justifiable or necessary, however, on lower maintenance sites or for pests of little concern. Counting small species is more accurate if it is done under a dissecting microscope. Counting methods that give an estimate of insect populations, including beneficial species, include:

- Count the number of insects found per leaf, per stem or per terminal shoot, then divide the total number of insects by the number of samples to get an average number of insects per sample.
- Inspect pre-determined number (50, 100, etc.) of leaves, shoots or other plant parts and record how many had the target insects present. This is a quick method that gives a percentage or

proportion of the total plant parts with an infestation.

The following sampling methods can be used simply to determine whether pests are present or they can be used to make more accurate population counts.

### Traps

- **Pheromone traps** can be used to monitor populations of cutworms, leafrollers, clearwing borers and other moths. These traps are usually inspected weekly for captured male moths and the counts would be recorded for comparison with previous counts.
- **Double sided sticky tape** can be used to catch immature scale ("crawlers") in the spring as they begin to move to feeding sites in the foliage. Count the number of crawlers caught on tapes every week under a microscope or visually compare the relative number of crawlers on sample tapes from one week to the next (for more information on scales, see IPM Examples at this end of the chapter). Tape traps can also be used to detect when rust mites (*Eriophyidae*) become active in spring and early summer.
- **Pitfall traps** are cans or plastic tubs buried with the top lip of the open container level with the soil surface. They catch large mobile insects, such as beetles, that travel over the surface. They fall in and cannot get out. Such traps can be used to collect adult root weevils for counting as well as beneficial ground beetles and rove beetles. Check traps often and release beneficial insects as soon as they are counted. To keep rain out of the traps, which would drown beneficial species, use a piece of shingle or other flat material as a cover. Support the cover 2-4 cm above the trap on small stones or pegs.

### Honeydew Cards

The droplets of honeydew from aphids on trees can be monitored using cards to catch the droplets. Special cards with moisture sensitive coatings (such as used for spray droplet detection) are available. Cheap, reusable sample cards can also be made from sheets of clear acetate with a 1-cm<sup>2</sup> grid pattern photocopied onto them to aid in counting. Clip the cards onto branches below infested leaves or lay them on the ground beneath trees for a set period of time (such as 1/2 hour or 4 hours). Count the number of droplets of honeydew and record this figure — or keep the cards and compare them visually from week to week to find out whether the relative amount of honeydew seems to be increasing or decreasing.

### Beating

As described in Chapter 1, insects that readily drop when disturbed can be knocked from foliage onto a beating tray below, by jarring the trunk or branches with a padded stick. This method is used to count adult black vine weevils (when done at night) as well as elm leaf beetles, thrips, leafhoppers and some species of caterpillars. It is also a good way to monitor for the presence of lady beetles, lacewings and other predatory insects. Mites on evergreen foliage can be detected by tapping the foliage over a clipboard covered with a sheet of light or dark paper.

**When and How Often:** The monitoring schedule depends on the life cycle of the problem insects and mites and on the time of year. Some insects, such as aphids and thrips reproduce throughout the growing season. Others, such as tent caterpillars have only one generation a year once the period of active feeding has passed they are no longer present or damaging. For a monthbymonth timetable for monitoring landscape and nursery pests in BC see the Nursery and Landscape Pest Management and Production Guide (see Further Reading at the end of this chapter).



## Action Decisions

Injury levels also depend on the category of site. For example:

- Class A Sites: Aesthetic injury levels may be quite low because plants are viewed at close range.
- Class B Sites: Proportionately higher pest populations may be acceptable in plantings that are less noticeable or less important in the landscape.
- Class C Sites: A relatively high level of plant injury is acceptable before action is taken. Action might only be taken if there is a risk of losing a plant to severe injury or where a pest outbreak might spread to a nearby, higher profile site or an agricultural crop.

Given the wide variety of climate zones, plants and possible pests, it is hard to generalize about injury levels. As for any landscape plantings, the injury level depends on how much damage the users of the site will tolerate. This, in turn, depends on where the damage is and how visible it is. Additional factors include long-term risk to the health of the plants and the risk of pests spreading to another site.

To begin with, it may be necessary to set temporary injury levels based on a best guess or on information found in publications. As monitoring records and treatment evaluations accumulate from year to year you will be able to refine the injury levels.

Some ways to define injury levels are:

- percentage or proportion of leaves damaged on a particular plant
- percentage of plants affected on a site
- number of pests counted
- number of pests counted in relation to the number of beneficial insects found
- number of complaints received from the public about a specific problem

The action levels depend on what types of controls are planned. For example, if biological controls are used, it is usually best to start releasing them while the target pest populations are still low. For a very damaging species, such as peachtree borer (*Synanthedon exitiosa*), the detection of one male in a pheromone trap might be the action level for an insecticide treatment to the tree trunk.

[Top](#)

## Treatment

One or several treatments may be coordinated into a management program for a target pest or for the entire complex of pests in a site or facility. Use biological, physical or cultural controls wherever possible to protect native beneficial species and reduce impacts on the environment. When a pest problem occurs that must be treated, the manager should re-evaluate the management program to determine how to prevent the pest problem in the future.

### Physical and Mechanical Controls

Examples of physical and mechanical controls for insects on ornamentals include:

- Strong sprays of water used to control aphids, spider mites and some sawflies, such as roseslug and pearslug (*Endelomyia* spp.).
- Removal of infested leaves by hand or by pruning out infested branches to manage light

infestations of aphids, scales, tent caterpillars or fall webworms.

- Sticky tree bands used to trap winter moth (see Chapter 3 for instructions) or elm leaf beetles. They can also be used to trap ants where they are protecting aphid colonies.

## Biological Controls

Only a few species of commercially produced biological control agents are practical for releases outdoors. As described in Chapter 1, conserving and attracting native beneficial species is the most useful approach outdoors. Useful commercial species are those that attack aphids (aphid midge, lady beetles and lacewings), as well as the insect parasitic nematodes (for control of root weevil larvae, borer larvae and cutworms) and predatory mites (for control of thrips, spider mites, rust mites and cyclamen mites). For detailed descriptions of the biological controls suitable for use in outdoor plantings, see Chapter 3.

In general, biological controls should be released as soon as monitoring shows target pests are present in enough numbers to support the predator population. Suppliers of biological controls provide monitoring and release rate information for using their products and should always be consulted before placing orders.

The microbial insecticide, *Bacillus thuringiensis kurstaki* (BTK) is a biological control (and a registered pesticide) used to control leaf-feeding caterpillars.

## Chemical Controls

Preferred insecticides are described in more detail in Chapter 3. Those of most use on ornamental plants in landscapes include:

- insecticidal soaps for chewing and sucking insects and spider mites
- pyrethrins for thrips, aphids and flying insects
- summer formulations of horticultural oils for scales, mites, aphids and lace bugs (*Tingidae*) (check labels for phytotoxicity information before using)
- dormant formulations of horticultural oils for overwintering stages of scales, mites, aphids and eggs of moths, such as leafrollers.

Generally, pesticides should be applied as spot sprays or in other targeted application methods. For example, systemic insecticides to control sucking insects can be applied as a band on the bark or injected into trees.

If an insecticide treatment is judged necessary, select the product according to the following guidelines. Make sure the product selected is:

- registered for the specific pests and intended use (application method, host plant)
- least likely to harm native beneficial insects and mites
- applied as a spot treatment instead of broadcast application wherever possible
- applied at the right time to have the greatest effect on target species

For more precautions and guidelines for using pesticides in landscapes, see Chapter 11.

• Top

## Evaluation



Follow-up monitoring or inspections are necessary to find out how successful an IPM program has been. It is essential to review records to determine what worked, where improvements should be made and what preventative steps may be possible in future.

## **IPM Examples**

Following are descriptions of three common groups of insects found in trees and ornamentals with notes on monitoring, action decisions and treatments that could be incorporated into an IPM program. In any IPM program, correct identification of the pests before taking action is critical, as is the evaluation step to determine how to improve the program in the future.

### **TENT CATERPILLARS (*Malacosoma* spp.)**

There are two common species of tent caterpillars in BC. The northern tent caterpillar (*M. californicum pluviale*) occurs mainly in southern half of the province and along the north coast. It feeds on alders, poplars, willows and fruit trees as well as many deciduous ornamentals. The forest tent caterpillar (*M. disstria*), is mainly found in the interior regions of the province. It prefers trembling aspen, but in outbreak years will feed on a variety of deciduous trees and shrubs. Unlike the northern tent caterpillar, and despite its name, the forest tent caterpillar does not make a silken tent of webbing in trees. Another common species, fall webworm (*Hyphantria cunea*), is often mistaken for tent caterpillars because they also make large silken tents in shrubs and trees. They appear in late summer, however, 1-2 months after tent caterpillars have left the trees to pupate.

The following information describes northern tent caterpillar, but the monitoring and management information can also be applied to forest tent caterpillars as well as fall webworms.

Northern tent caterpillars are the larvae of a large, pale brown moth that lays its eggs in late summer on the small branches of deciduous trees (ash, birch, fruit trees, oak, poplar). The egg masses look like 1-2 cm long masses of hard brown foam, usually wrapped around branches less than 1 cm in diameter. The eggs hatch from mid-April to early June. The larvae feed together in large numbers, spending the night and periods of bad weather in a nest of silken webbing they spin in the crotches of branches. When the larvae reach full size (June to early July) they wander from the trees in search of pupation sites. The adult moths emerge in late summer. Webbing stays in the trees long after the caterpillars have left. Tent caterpillar populations naturally rise and fall in a 7-10 year cycle of outbreak, followed by a collapse as the population is wiped out by naturally occurring diseases and predators.

• [Top](#)

## **Monitoring**

Inspection of dormant branches for egg masses can be done any time after the leaves drop. Before the leaves expand, hatching egg masses are particularly easy to see on branches silhouetted against the sky. In expected outbreak years, monitoring for hatching egg masses should start by mid-April.

## **Action Decisions**

In peak outbreak years, trees may be completely defoliated. Although this may temporarily weaken trees, it usually does not cause long-term harm. Once the caterpillars leave in early summer, the trees produce new leaves to fill in the canopy. This means that the injury level mainly depends on the perception of the site users rather than danger to the trees. In practice, although defoliated trees are a source of public concern, by the time complaints are made to municipalities and parks departments,

it is often too late to do much about the current year's infestation. Whether or not caterpillars are removed from individual trees, the tent caterpillar populations in the area will increase over several years and then collapse as diseases and natural enemies catch up with the population. In expected outbreak years, monitoring for egg masses and hatching caterpillars will make it possible to apply treatment early enough to protect trees from defoliation.

## **Treatments**

Although treatment is usually not necessary to preserve the long-term health of trees, pruning out the egg masses and web nests may be desired on high visibility plantings. Remove webs in the evening after caterpillars have returned to the nest. Destroy the caterpillars by crushing them or dropping them in a bucket of soapy water.

To control the caterpillars while they are still actively feeding in the trees, the microbial pesticide, BTK is useful if applied carefully to ensure good coverage of the foliage. High pressure water sprays can also be used to remove caterpillars and webbing and to clean old webbing out of trees after the caterpillars have left.

[• Top](#)

## **SCALES**

Various species of scale insects attack woody ornamentals in BC. Scales are sap-sucking insects that look like tiny bumps or plates on twigs and leaves. Armoured scales (*Diaspididae*) have a harder shell and do not excrete honeydew. They include oystershell scale (*Lepidosaphes ulmi*) and San Jose scale (*Quadraspidiotis perniciosus*). Soft scales (*Coccidae*) are usually smooth or cottony and excrete honeydew (copiously!). They include lecanium scale (*Lecanium* spp.) and soft brown scale (*Coccus hesperidum*).

It is not easy to identify scale species, however, it is essential because there are important differences in behaviour and life cycles of the various species that affect timing of treatments. Some species overwinter as eggs that hatch in the spring. The immature "crawlers" move around the plants for a short period early in the season before settling down to feed. Other species, such as the main pests of fruit trees in the interior regions of BC, overwinter as adult scales. They mate in the spring and the crawlers hatch out in June and July and move to suitable feeding sites. Knowing when the crawler stage is on the move is key because this is the stage that is most susceptible to insecticides. Adult scales are well protected from sprays by their waxy shells, as are the eggs, which are also protected by the shell of the female.

## **Monitoring**

For species that overwinter as eggs, start monitoring for the crawler stage 1-2 weeks before buds break in the spring. For species that overwinter as adults, start monitoring in mid-summer. Wrap double sided sticky tape tightly around twigs or small branches on susceptible plants. Fold over the end of the tape to make a tab to grip when removing the tape. Tie flagging tape or another marker near each taped twig so that you can find it again. Once a week, pull off the sticky tapes and stick them flat on a white sheet of paper. Look at the tapes under a microscope to distinguish the tiny, yellow or orange crawlers from specks of dust or pollen. If time permits, count the crawlers and keep the weekly records of counts. If not, keep all of the sample tapes on paper. Cover them with a clear sheet of acetate, labeled with dates and locations, and compare them visually from week to week.

## **Action Decisions**

Injury levels have not been established for scale, however, with experience (and good records, of course) you should be able to establish your own idea of injury levels. If an insecticide treatment is needed, it should be done when the number of crawlers on the sticky tapes shows a marked jump upward in numbers from one week to the next.

• Top

## Treatments

### Biological Controls

For outdoor plants, naturally occurring predators and parasitic wasps often provide adequate control. Make the landscape more attractive to these beneficial insects by planting flowers that are good sources of nectar near trees attacked by scales.

### Physical Control

Prune out and destroy infested branches.

### Chemical Control

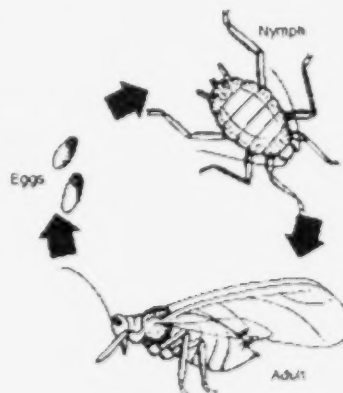
Used at the right time, non-residual insecticides are effective on the crawler stage of scales and cause the least harm to the natural enemies of scales. Spray insecticidal soap or horticultural oils when monitoring shows that peak numbers of crawlers are moving on the twigs. Applying horticultural oils when buds are swelling in the spring minimizes the harm to beneficials and is a useful control for overwintering stages of scales.

Several organophosphate and carbamate insecticides are registered as foliar sprays for scale. Use of these pesticides, however, will disrupt naturally occurring biological control of scale and should be avoided if possible. In extreme situations, a band of the systemic pesticide dimethoate can be painted onto trunks to spread through the plant (this is registered for use on only a few ornamentals, such as roses, lilac, birch). This application method affects the scales without disrupting populations of natural enemies.

• Top

## APHIDS

Aphids are small, pear-shaped sucking insects, 2-8 mm long, with long, backward pointing antennae. Many different species of aphids occur on outdoor plants, including rose aphid (*Macrosiphum rosae*), spruce aphid (*Elatobium abietinum*) and maple aphids (*Periphyllus* spp. and *Drepanaphis* spp.). Most aphid species attack only a few closely related species of plants and won't spread to unrelated plants. For example, aphids attacking maples will not spread to roses. Some aphid species do alternate between two types of host plants. For example, black cherry aphid (*Myzus cerasi*) starts in the spring on cherry, moves to mustard family (*Brassicaceae*) plants in summer, then back to cherry in the fall to overwinter; leafcurl plum aphid (*Anuraphis helichrysi*) starts on plum, moves to sunflower



family (*Asteraceae*) plants, then back to plum in the fall.

Aphids suck plant sap, causing distorted foliage and buds and dropped leaves. They also excrete a sweet honeydew which drips onto leaves and supports the growth of unsightly sooty moulds. Aphids reproduce continuously during the growing season. Most species overwinter in the egg stage on branches and twigs.

## Monitoring

Visual inspections: Inspect plants weekly for distorted, curled foliage and shiny drops of honeydew on leaves. Use a 10-15 X hand lens to look for aphid colonies, concentrating on new growth and growing tips as well as the undersides of oldest leaves.

## Counting Methods

- Count the number or percentage of terminal shoots, leaves or plants infested with aphids. Start checking plants that are susceptible to aphids in the spring, before aphids are expected to appear. Every 1-2 weeks, check 5 to 10 leaves, or shoots, per plant. Inspect several plants in each area. While checking for aphids, record the number of aphid predators seen as well.
- Count the number of honeydew droplets falling over a 1/2 hour, 2 hour or 4 hour period on cards placed under foliage. Special, water-sensitive cards used to monitor for spray drift are easy to use. Cheaper alternatives, such as sheets of acetate or dark construction paper, also show droplets well enough to allow droplets to be counted. Clip the card to clipboards and set them out in mid-day. Place them on the ground beneath trees or fasten them to lower branches.

## Action Decisions

Examples of injury levels used by pest managers for various species of aphids on:

- "Background" plantings: (i.e., where honeydew will not fall on walks, patios, parked cars, etc.)  
20- 40% of terminal leaves infested.  
¥ Roses: 5-10% of terminal leaves infested.  
¥ Other plants: less than 1 aphid predator per 50 aphids. This means that if there is more than 1 predator/50 live aphids, then it is likely that there are enough natural enemies present to control aphids without other treatments. The ratio of live aphids to dead aphids can also be used as an indicator of predator activity.

For sites where honeydew is the main problem caused by aphids, such as on boulevard trees, an action threshold might be established based on some number of honeydew droplets deposited on monitoring cards per hour. What that number is depends on the site. For example, if the honeydew is falling on a sidewalk, the tolerable amount may be much higher than if it is falling on parked cars.

Where biological controls are going to be released, the time to release predators is usually in the early spring, as soon as aphid colonies are found during regular monitoring.

[Top](#)

## Treatments

### Biological Control

Many species of aphid predators and parasites are native to BC and common even in urban environments. As described in Chapter 1, protecting them is the cheapest approach for long-term suppression of aphid populations.

Research in BC on releasing commercially reared aphid midge, *Aphidoletes aphidimyza*, has shown promising results on boulevard and shade trees, roses and other shrubs. Generally, aphid midges are released in the spring, 2 or 3 times at 7-10 day intervals to add to the naturally occurring populations of aphid predators. A late summer release of aphid midges on *Malus* and *Prunus* trees with established aphid colonies can be used to reduce the overwintering aphid population. Always consult biological control suppliers for their advice on release rates and timing.

### Physical Control

- Prune out infested branch tips or foliage.
- Remove aphids by spraying the plants with a strong stream of water. Knocking the aphids loose from the plants damages their mouthparts and prevents them from feeding again.

### Chemical Control

Aphids are difficult to control with pesticides because spray coverage must be very thorough to reach aphids on undersides of leaves and in curled leaves; if any aphids survive they quickly generate a new colony. Aphid populations readily become resistant to pesticides that are used frequently.

Avoid using residual insecticides, especially as foliar or broadcast sprays because this can cause a more severe aphid problem in the future by killing the native aphid predators.

- If required, use non-residual insecticides, such as insecticidal soap or horticultural oil; apply them as spot sprays whenever possible.
- Dormant oil sprays are effective on overwintering eggs of aphids on deciduous trees when applied just before the buds start to open.
- In extreme situations, a band of the systemic pesticide dimethoate can be painted onto trunks to spread through the plant (registered on only a few ornamentals, such as roses, lilac, birch). This application method affects the aphids without disrupting populations of natural enemies.

[Top](#)

### Further Reading

\_\_\_\_\_. 1997. Plant Health Care for Woody Ornamentals. A Professional's Guide to Preventing and Managing Environmental Stresses and Pests. International Soc. Arboriculture and University of Illinois. 223 pp. (From: University of Illinois, ITCS, 1401 South Maryland Drive, Urbana, IL 61801. Tel: 800-345-6087 Web: <http://www.extension.uiuc.edu/pubs.html>)

\_\_\_\_\_. 1998. Nursery and Landscape Pest Management and Production Guide. BC Ministry of Agriculture & Food and BC Landscape & Nursery Association (From: BCLNA, Suite 101, 5880-176A St., Surrey, BC V3S 4E3. Tel: 604-574-7772)

\_\_\_\_\_. 2000. Tree Fruit Production Guide for Commercial Growers, Interior Districts. Min. of Agriculture & Food and BC Fruit Growers' Assn. (From: BCFGA, 1473 Water St., Kelowna, BC V1Y 1J6. Tel: 250-762-5226).

Bobbitt, V., A. Antonelli, C. Foss, R. Davidson, R. Byther and R. Maleike. 1996. Pacific Northwest



Landscape IPM Manual. Washington State University. 206 pp. (From: WSU, Cooper Publications Bldg., P.O. Box 645912, Pullman, WA 99164-5912. Tel: 1-800-723-1763 Web: <http://pubs.wsu.edu/cgi-bin/pubs/index.html>)

Dreistadt, S. H. 1994. Pests of Landscape Trees and Shrubs: An Integrated Pest Management Guide. Pub. # 3359, University of California. 327 pp. (From: ANR Publications, Univ. of Calif., 6701 San Pablo Ave., Oakland, CA 94608-1239. Tel: 800-994-8849 Web: <http://anrcatalog.ucdavis.edu/>)

Flint, M. L. and S. H. Dreistadt. 1998. Natural Enemies Handbook: The Illustrated Guide to Biological Pest Control. Pub. #3386. University of California. 154 pp. (From: ANR Publications, Univ. of Calif., 6701 San Pablo Ave., Oakland, CA 94608-1239. Tel: 800-994-8849 Web: <http://anrcatalog.ucdavis.edu/>)

Gerber, H. S., D. J. Ormrod and M. A. Waring. 1995. A Gardener's Guide to Pest Prevention and Control in the Home and Garden. BC Ministry of Agriculture and Food. 175 pp. (From: Crown Publications, 521 Fort Street, Victoria, BC V8W 1E7. Tel: 250-386-4636 Web: <http://www.crownpub.bc.ca/>) [Revised edition available Fall 2000]

Matteoni, J. A. and D. Elliott. 2000. Applied Biological Control Manual: Greenhouse and Protected Crops. Applied Bio-Nomics Ltd. (From: ABN, 11074 W. Saanich Rd., Sidney, BC V8L 5P5 Tel: 250-656-2123. E-mail: [bug@islandnet.com](mailto:bug@islandnet.com))

Olkowski, W., S. Daar, & H. Olkowski. 1991. Common Sense Pest Control. Taunton Press, Newtown, CT. 715 pp. (From: Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707. Tel: 510-524-2567 Web: <http://www.birc.org/>)

Pirone, P.P. 1978. Disease and Pests of Ornamental Plants. 5th ed. John Wiley & Sons, Toronto. 566 pp.

• [Top](#)

### Study Questions

1. How do urban environments differ from natural growing conditions? List 4 differences that cause problems for plants.
2. Why is it particularly important to choose pest resistant cultivars of long-lived, woody plants?
3. To use indicator plants for monitoring, a pest manager must know \_\_\_\_\_ and \_\_\_\_\_. (fill in the blanks)
4. Which of the following could be ways to define injury levels for pests in ornamentals:
  - a) percentage of leaves damaged on a particular plant
  - b) percentage of plants affected on a site
  - c) number of pests counted
  - d) number of complaints received from the public
  - e) all of above
  - f) a, b, and c but not d
5. What pests can be controlled using the following treatments? (give at least one example for

each).

- a) strong sprays of water
- b) sticky tree bands
- c) *Bacillus thuringiensis kurstaki*

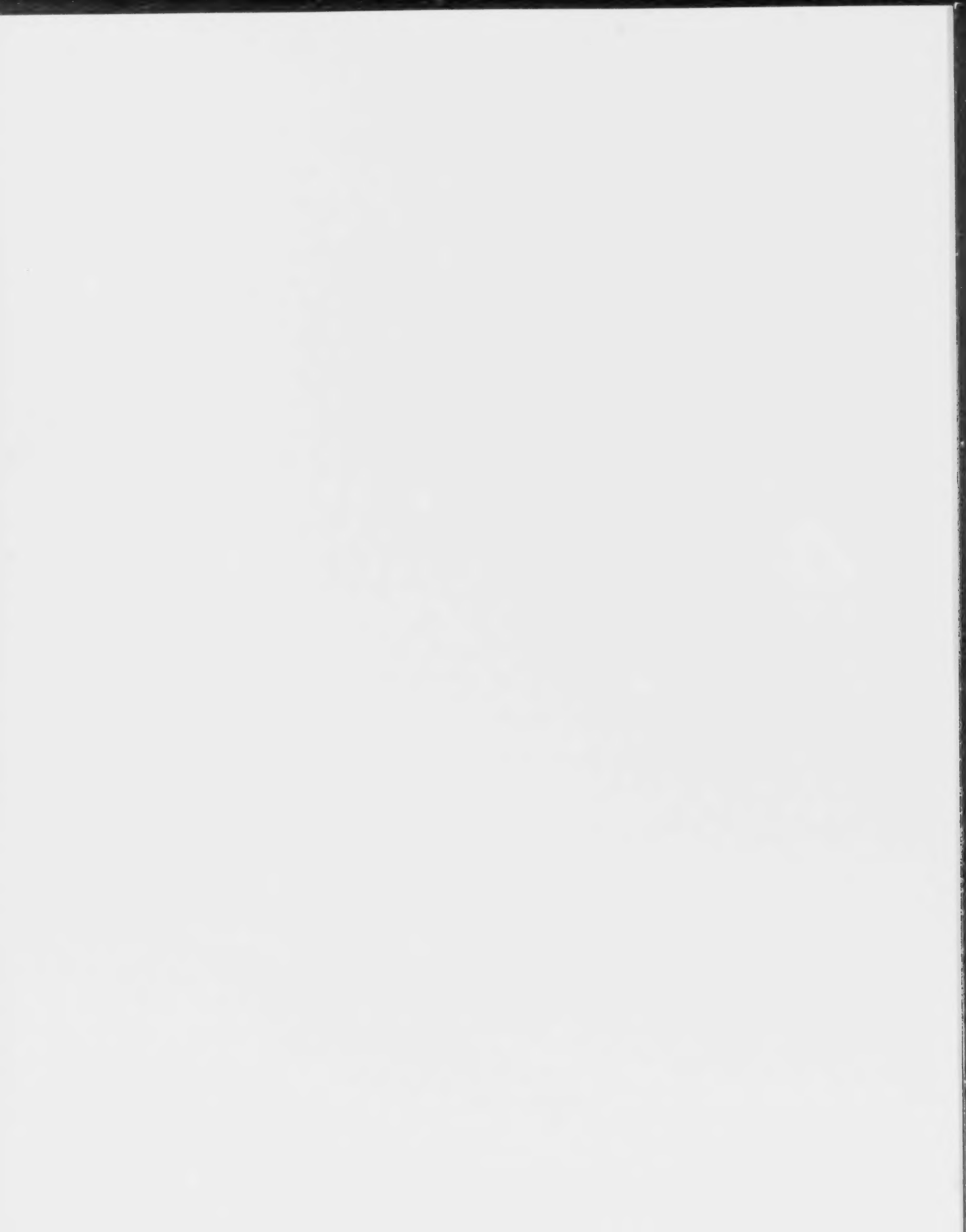
[Return to Table of Contents](#)

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.







## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

## Chapter 10 — IPM for Diseases in Ornamentals & Trees

### *Learning Objectives*

When you have completed this lesson, you should be able to:

1. *Classify ornamentals and trees into three categories according to maintenance level.*
2. *Describe two main methods of preventing disease problems in ornamentals.*
3. *Know where to look for help in identifying diseases.*
4. *Describe general disease monitoring methods used in ornamentals and trees.*
5. *Describe cultural controls that can be used to manage diseases in ornamentals.*
6. *List general guidelines for using fungicides to control fungal diseases.*
7. *Describe the role of evaluation in an IPM program for diseases in ornamentals.*
8. *Describe monitoring methods, give examples of action levels and treatments for powdery mildew and anthracnose.*

### *Introduction*

This category includes trees, shrubs and ornamental plants in gardens, residential yards, parks and institution grounds, playgrounds, golf courses, boulevards and natural areas. Common diseases in landscape ornamentals in BC caused by bacteria include bacterial blight (*Pseudomonas syringae*), crown gall (*Agrobacterium* spp.) and fire blight (*Erwinia amylovora*). Diseases caused by fungi include powdery mildews (many species), Botrytis blight (*Botrytis cinerea*), root rots (caused by *Pythium*, *Phytophthora*, *Armillaria* spp.), Verticillium wilt and various rusts. Not all diseases are found throughout the province. For example, bacterial blight is a common problem in cool weather on the coast, while fire blight is mainly a problem in the interior regions of the province.

This chapter is intended to provide the general framework of an IPM program for diseases in ornamentals. For more specific information, consult additional references listed at the end of this chapter, particularly the Nursery and Landscape Pest Management and Production Guide, which gives more detailed information on cultural methods and other controls for specific diseases.

As described in Chapter 2, using a system for categorizing sites according to maintenance level can help in planning an IPM program.

## Facility Categories

Examples of sites that might be included in each category include:

- Class A - High level of service: rose and specialty gardens, display areas of parks and boulevards, residential front yards, golf courses and institution grounds.
- Class B - Moderate level of service: plantings in neighbourhood parks, playgrounds, residential backyards, along boulevards.
- Class C - Low level of service: greenbelt areas, vacant municipal land, highway plantings; natural areas of yards and parks.

The following section describes the general steps in an IPM program for disease management and gives examples of techniques currently available. Outlines of IPM programs for two common diseases are also included. This information is intended as a starting point, to be adapted to suit specific sites and improved as new products and methods are developed.

• [Top](#)

## Prevention

As described in Chapter 9, landscape plants are often grown under conditions that stress the plants. It is important to correct growing conditions that stress plants because healthy plants can defend themselves against bacteria, fungi, viruses and other microorganisms (see box).

### Plants Get Defensive

Plant cells can detect the presence of an infectious agent (called a pathogen) and mobilize a response that neutralizes the invader. One way they do this is by signaling to the cells around an infected area to die. The layer of dead cells isolates the infection from the rest of the plant and causes the corky spots or holes in leaves that are characteristic symptoms of some diseases. Other responses to infection are uncannily like our own immune system because exposure to a pathogen activates genes that cause the plant to become resistant to later attacks. This resistance can extend to a broad range of other pathogens as well. Recently, researchers have even discovered how some plant cells produce molecules that inactivate the genetic code of viruses. Once produced, these anti-virus molecules were found to spread rapidly throughout the plant.

Before any disease can occur, the three elements of the "disease triangle" must be present: a susceptible plant, the disease agent (called a pathogen) and favourable environmental conditions for development and spread of the pathogen. Disease does not develop if any of these are missing, therefore prevention of diseases is based on removing one or more of these elements.

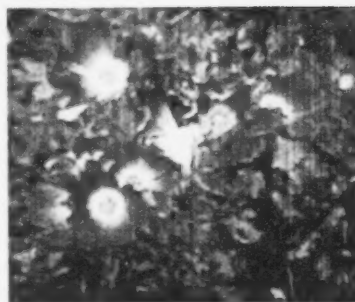
The elements of prevention (also called "cultural controls" in some references) for ornamental pests are:

#### a) Use optimum site design

When designing and planting landscape plantings, start with the correct drainage, soil preparation, diversity of species and cultivars adapted to the site and climate. Inspect and purchase only disease free stock.

### b) Choose pest resistant plants

Select disease resistant and disease tolerant cultivars rather than disease susceptible plants. Many ornamental plants are now available with resistance to various pathogens. For example, there are cultivars of roses resistant to powdery mildew and black spot, flowering cherries resistant to bacterial blight, and other plants resistant to verticillium wilt, armillaria root rot, fire blight, scab or rusts. Tables of disease resistant and susceptible plants are included in the Nursery and Landscape Pest Management and Production Guide (see Further Reading at the end of this chapter). A long-term pest management plan may include replacing the most susceptible plants with less susceptible species and cultivars wherever possible. This is particularly important for plants affected by diseases for which there are no satisfactory controls.



*Disease Free Rose*

In some cases, plants that are susceptible to a particular disease when they are young, seem to grow out of their susceptibility as they get older. For example, hawthorn blight (*Entomosporium mespili*) seems to be more severe on young trees than older trees, while 'Kwanzan' ornamental cherries are susceptible to bacterial blight (*Pseudomonas syringae*) when young, but often become resistant as they mature.

### c) Use management practices that ensure healthy plants.

See Chapter 9 for a more complete list of management methods that contribute to healthy, pest-resistant ornamental plantings. Specific methods with respect to disease management include:

- Prevent injuries to plants from equipment and from freezing temperatures.
- When inspecting planting stock for health, check tree root collars for circling, kinked roots, basal cankers and check the condition of main roots.
- Prune and space trees and branches to promote air circulation and rapid drying of the foliage after rainfall or irrigation. Avoid planting susceptible plants in damp or shady locations to reduce fungal infections.
- Reduce disease inoculum levels by removing alternate host plants (other species that also carry the disease) and never plant a susceptible plant in the same place where a plant has been taken out due to disease.
- Prune and train young trees correctly so that large pruning cuts will not be needed later to improve poor tree structures. Make cuts properly to promote rapid wound closure and minimize the number of pruning cuts, which allow pathogens to enter.
- Manage irrigation to avoid overhead watering on plants susceptible to bacterial blight, rusts, scab (*Venturia* spp.), black spot of roses (*Diplocarpon rosae*) and other diseases that germinate in wet conditions. Water early in the day so that leaves have time to dry before evening.

• Top

## Identification

Due to the wide variety of trees and shrubs grown in BC, there are potentially many different diseases that can occur. Diseases are often difficult to diagnose because different diseases have similar symptoms. Symptoms may be mistaken for injury caused by poor growing conditions. Also, symptoms that appear on one part of a plant, such as wilting leaves, can be caused by a pathogen attacking another part of the plant, such as the roots. Some diseases can only be positively identified by a plant pathologist.

To make an accurate diagnosis, it is usually necessary to collect affected leaves or other plant parts and inspect the samples carefully under a microscope or hand lens. You may need to watch the affected plant over a several days or weeks to see changes in symptoms that will help in diagnosis. Knowing what the weather conditions have been in the previous weeks can be helpful, especially with fungal diseases (see Monitoring, below). It is also important in diagnosing the problem to know what other conditions may be affecting the plant and promoting disease. Examples of this would be waterlogged soil, damage from frost, sunscald or herbicides, nutrient imbalances or low light levels.

Compare these samples with photographs in identification guides using:

- signs of the disease, such as fruiting bodies (fungal growths that produce spores), filaments or threads of growing fungi (called mycelium)
- symptoms of disease, such as wilting, colour of leaves, shape and size of leaf spots and discolourations

Identification resources include:

- reference books, insect guides (listed at the end of this chapter)
- resources on the internet
- staff at garden centres, community colleges, botanical gardens
- professional diagnostic services

Note: Professional services and companies can send samples to the provincial Plant Diagnostic Laboratory, Ministry of Agriculture, Food and Fisheries, 1767 Angus Campbell Road, Abbotsford, B.C. V3G 2M3. Phone: 604-556-3126 (there is a charge for this service). Contact the laboratory for specific instructions on how to collect and package plant samples. When sending samples to a lab provide as much background information as possible about weather conditions, cultivars, any pesticide use, fertilizing, irrigation and other management practices. See Appendix I for a lab submission form.

To help in future identification it is a good idea to keep photographs and descriptions of disease symptoms that occur on various sites.

[Top](#)



*Using a Hand Lens  
for Inspection*

## Monitoring

Unlike other kinds of pest problems, once the symptoms of diseases are visible, it may be too late to control it on the infected plant. This means that, in addition to looking for disease symptoms, monitoring should include looking for growing conditions that favour disease. Monitoring for diseases in ornamentals includes visual inspections of plants, keeping weather records and using counting methods.

## Visual Inspections

Use a hand lens to take a close look at the plant. Use tools, such as a soil probe, shovel or pocket knife as needed, to explore around roots, dig into soil or cracks in bark, etc. Look for conditions that favour disease, such as:

- injuries to bark or foliage that could allow pathogens to enter the plant
- soil that is compacted, overwatered, too dry, too cold or too warm for the plants on the site

- conditions that allow leaves or roots to stay wet for long periods, such as dense foliage, poor drainage or water runoff from other sites
- presence of sucking insects, such as aphids, whiteflies, leafhoppers, that might spread viruses between plants
- alternate host plants with infections that could spread to the landscape plants (i.e., pears that harbour pear trellis rust, which also infects juniper)

Look for signs and symptoms of disease, such as:

- wilted, distorted or abnormally shaped shoots and leaves
- spots, streaks or discolourations on leaves, stems, and flowers
- discoloured, distorted or damaged roots
- presence of fruiting bodies or visible mycelium

### Weather Records



The right conditions of humidity and temperature are key factors in the development of many diseases, particularly those caused by fungi and bacteria. For this reason, monitoring may also include keeping records of temperatures (daily minimum and maximum, if possible), rainfall and relative humidity. These records will help you know when conditions have been favourable for specific bacterial or fungal disease infections so that you can monitor or treat accordingly (see text box for examples of rose diseases).

*Looking for  
Symptoms  
of Disease*

#### Conditions Favouring Diseases of Roses

| Pathogen                                          | Optimum Temperature         | Optimum Relative Humidity (RH & Moisture)               |
|---------------------------------------------------|-----------------------------|---------------------------------------------------------|
| Blackspot<br>( <i>Diplocarpon rosae</i> )         | 18 - 24°C                   | Spores must be continuously wet over 7 hrs to germinate |
| Powdery mildew<br>( <i>Sphaerotheca pannosa</i> ) | Day 21 - 26°C<br>Night 16°C | RH*: Day 40 - 70%; night 90 - 99%                       |
| Rust ( <i>Phragmidium</i> spp)                    | 18 - 21°C                   | Continuous moisture 2 - 4 hrs                           |
| Downy mildew<br>( <i>Peronospora sparsa</i> )     | <18°C                       | RH#: over 85%                                           |

\*RH = relative humidity

• Top

### Counting Methods

Counting diseased plants or plant parts may not be as useful in most landscapes as careful visual inspections and monitoring weather conditions. This is because landscapes are usually planted with a variety of plant species and, since most pathogens attack only particular species, diseases are usually limited to those few susceptible plants. Where there are large numbers of the same plants in an area, however, counting methods are useful in making decisions about treatments. This is because they tell you whether a disease is getting worse or spreading. For diseases that appear every year, start inspections early to detect the first infections and use counting methods to track the progress of the disease. This information, along with weather records, can be used to time preventative fungicide applications and other treatments.

Examples of counting methods include:

- count the number of leaves, branches or plants with symptoms
- measure the severity of symptoms using a scoring system (see text box) for estimating area of leaves affected by symptoms

### Scoring Disease Symptoms

Developing a scoring system is a good way to monitor for diseases with readily identifiable symptoms, such as leaf spots or blotches. Scoring systems can be based on any number of categories of damage. To be practical, however, they usually divide the range of damage into 4 to 6 categories. The categories range from "no symptoms" to the most severe.

A monitoring system developed for hawthorn blight in Victoria\*, where over 11% of the boulevard trees are hawthorns, is based on 6 categories of leaf symptoms. When trees are inspected, the severity of the symptoms are scored on a scale starting with 0 (no symptoms), 2 (some brown spots), 4 (more spots), 6, 8 and 10 (defoliation). A simple way to analyze these records is to calculate the proportion of inspected trees that scored in each category. For example, if a total of 60 trees are inspected and 15 had no symptoms, 25% would be in the "0" category. Do this calculation for each category. The percentage of trees in each category can be displayed in a table or bar graph for comparison with other monitoring dates.

It is a good idea to make a score guide with pictures or drawings that clearly illustrates the amount of damage to associate with each score. This will standardize the scoring and reduce the differences in interpretation between people doing the monitoring. The same scoring system should be used each time so that results can be compared from year to year.

\*Information from Dr. Michelle Gorman, IPM Coordinator, City of Victoria

### When and How Often

The monitoring schedule depends on the category of the site, what diseases are expected to occur on the plants, the weather and on other conditions that promote disease. Monitoring for disease symptoms is usually done weekly, or more often, during the seasons or periods of weather that favour disease development. It is important to be familiar with what diseases to expect on various plants in the landscape so that you can plan an efficient monitoring program.

• [Top](#)

### Injury and Action Levels



Injury levels also depend on the category of site. For example:

- Class A Sites: Aesthetic injury levels may be quite low because plants are viewed at close range.
- Class B Sites: A higher level of damage may be acceptable in plantings that are less noticeable or important in the landscape, providing disease is not likely to kill the plant.
- Class C Sites: A relatively high level of plant injury is acceptable before actions are required. Action might only be taken if there is a risk of losing a plant to severe injury or where a disease outbreak might spread to related plants in nearby, higher profile site.

Given the wide variety of climate zones, plants and possible diseases, it is hard to generalize about injury levels. As for any landscape plantings, the injury level depends on how much damage the users of the site will tolerate, which in turn depends on where the damage is and how visible or severe it is. For diseases, an important factor is whether or not the long-term survival of the plant is threatened or whether there is a risk of the disease spreading to another site. In practical terms, how much it costs to treat or replace the plant will also affect tolerance for damage.

To begin with, it may be necessary to set temporary injury levels based on a best guess or on information found in publications. As you accumulate monitoring records and treatment evaluations from year to year, you will be able to refine the injury levels.

Some ways to define injury levels are:

- percentage or proportion of leaves damaged on a particular plant
- percentage of plants affected on a site

The action levels depends on what type of controls are planned. For example, most fungicides work by preventing the pathogen from infecting healthy tissue, rather than by killing the pathogen directly. This means that on high risk plants, such fungicides would be used when there is a sound basis for expecting infection to occur (such as poor weather conditions).

• Top

## **Treatment**

When a disease occurs that must be treated, the manager should re-evaluate the plant management program with the aim of strengthening the plant's natural defenses or altering the plant's environment to reduce damage or prevent the problem from occurring in the future.

## **Cultural Controls**

The main cultural controls for plant diseases (in addition to measures also described above, under Prevention) are sanitation methods including:

**Pruning:** Not to be confused with pruning to shape plants and increase air circulation, sanitation pruning is done to remove infected branches, foliage and other plant parts. It is usually done as soon as infections are found, at any time of year. For some diseases, however, it is important to time pruning so that it is done when there is less likelihood of spreading the disease. For example, the greatest number of bacteria are present on plants infected with bacterial blight in the spring; pruning at this time has a much higher risk of spreading the infection than pruning in mid-winter or on a dry day in mid-summer.

Burn or bury infected material, well away from susceptible plants. When working on plants with disease symptoms (or suspected symptoms), disinfect pruning tools between cuts using rubbing

alcohol, a 10% household bleach solution or other disinfectant. When the job is done, thoroughly clean tools and equipment, wash soil and leaves off of shoes and wash hands before working on other plants.

**Plant Removal:** Always remove and destroy infected plants before planting new stock at the site. Take care in selecting replacement stock to ensure it is not susceptible to the same disease. Where the ongoing cost of managing plant disease is high, or treatments do not provide satisfactory control, it is often best to replant even if the disease does not kill the infected plants. For some plant diseases, removing alternate host plants that keep infections going in the area is preferable.

### Removing Cherry Trees with Little Cherry Virus Disease

Little Cherry Virus (LCV) causes some or all of the fruit on infected trees to be smaller than normal, poorly coloured, and lacking in flavour and sweetness. Removing diseased trees is essential for control of this disease, therefore LCV is a declared pest under the provincial Plant Protection Act. This applies to the main cherry growing areas of British Columbia, including the Okanagan region and the Creston valley. Cherry trees with suspected symptoms should be reported to the local Ministry of Agriculture, Food and Fisheries office. Ornamental flowering cherries can be symptomless carriers of LCV so they are also prohibited within the control areas. Virus-infected trees cannot be cured, but controlling the insect that spreads the virus (apple mealy bug), will help prevent the spread of LCV.

For more information see the Tree Fruit Production Guide for Commercial Growers, Interior Districts (under Further Reading).

**Leaf Removal:** Rake up and destroy fallen leaves from plants infected with pathogens that over winter on fallen leaves. This includes blackspot (*Diplocarpon rosae*) on roses and scab (*Venturia* spp.) on apples and other related plants. Removing infected leaves from plants and destroying them is also a sanitation step that can reduce the spread of fungi that attack leaves.

• Top

## Physical and Mechanical Controls

**Water Washes (Syringing):** Using plain water to rinse leaves is a long-established practice for suppressing powdery mildew. This is because free water on the leaves stops powdery mildew spores from germinating. Sprinkling or syringing is best done in mid-day to give plants time to dry off before nightfall and avoid other fungal diseases. Water sprays would not be advisable on plants susceptible to rusts, scab (*Venturia* spp.), bacterial blight or other diseases that are promoted by wet conditions.

**Cauterization (Applying Heat):** One research study found that using a hand-held propane torch to burn cankers caused by *Pseudomonas* on stone fruit trees limited the spread of the disease. This is experimental but may be worth trying.

## Biological Controls

Beneficial microorganisms that suppress plant pathogens are naturally present in the soil, the air and on leaf surfaces. These include:

- mycorrhizal fungi that colonize plant roots and protect the plant from infection. These prevent attack by pathogens and help plants take up nutrients from the soil. Most research on

- mycorrhizal products has been on seedling mixtures for forest nurseries and agricultural crops.
- microorganisms that attack, disable or inhibit the growth of pathogens (products containing these are registered as pesticides)

At this time, the use of soil amendments containing microorganisms is still experimental. There are very few biological controls registered in Canada for controlling plant disease. One is *Agrobacterium radiobacter*, which is a beneficial species of bacteria. It controls crown gall (*A. tumefaciens*) and is used as a root dip on nursery stock, roses, clematis, chrysanthemums, flowering *Prunus* spp., willow, juniper and other ornamentals (for more information see Chapter 3).

Other biological controls for plant diseases are available in the US and may be registered in Canada in future. Some of these include:

- The common, soil-dwelling fungus, *Trichoderma harzianum*, which suppresses *Pythium*, *Fusarium* and *Rhizoctonia* in soil mixes, turf and other applications.
- The parasitic fungus, *Ampelomyces quisqualis*, which attacks many species of powdery mildew fungi.

• Top

---

## Chemical Controls

Most chemicals available to control plant diseases are fungicides; a few products that contain copper as the active ingredient also work on bacteria. No products are available to control viruses directly. Some viruses are transmitted by insects, however, and these may be indirectly controlled by controlling the insects that spread the viruses. For some diseases, prevention and cultural controls are the only approaches available because there are no effective pesticides registered.

If a chemical treatment is required, select the product according to the following guidelines. Make sure the product selected is:

- effective and registered for the specific pathogen, and
- applied at the right time to provide protection or to have the greatest effect on target species.

Timing is very important for applying preventative (protectant) fungicides because they have little effect if applied after the infection period has ended. Always check the life cycle of the pathogen to find out when the infection period occurs and time fungicide treatments accordingly.

For more precautions and guidelines for using pesticides in landscapes, see Chapter 11.

• Top

---

## Evaluation

After any type of treatment, use visual inspections or counting methods to assess the effect. Follow-up inspections include checking for:

- further spread of disease symptoms
- reduction or elimination of disease symptoms
- restoration of plants to normal growth or appearance

Use this information, along with other monitoring records, observations from field staff, feedback from

clients, budget records, etc. to assess the effectiveness of the IPM program and find ways to improve it for next year.

## **IPM Examples**

Following are descriptions of two common plant diseases in BC, with notes on monitoring, action decisions and treatments that could be incorporated into an IPM program. In any IPM program, correct identification of the pests before taking action is critical, as is the evaluation step to determine how to improve the program in the future.

### **POWDERY MILDEW**

There are hundreds of species of powdery mildew fungi that may attack landscape plants (e.g., species of *Erysiphe*, *Sphaerotheca*, *Uncinula*, *Podosphaera*, etc.). Some are limited to particular hosts, such as *Sphaerotheca pannosa* var. *rosae*, which only attacks roses, while others infect a wider range of plants.

The disease usually appears as whitish or grayish powdery patches on leaves or young growing tips. The spores spread on the wind and can only live in plant tissue. Leaves do not need to be wet to enable the spores to germinate — in fact, the spores die in water. Spores overwinter in dormant buds and on fallen leaves, but not in the soil. Development of powdery mildew is greatest on plants in the shade and during humid weather. The fungus releases the most spores when dry warm days are followed by cool nights. Both rainfall and direct sunlight inhibit growth of powdery mildews.

How damaging powdery mildew diseases are depends on what species of fungus is involved, the species or cultivar of the host plant, the age of the plant tissue being attacked and the environmental conditions (i.e., relative humidity, temperature).

[Top](#)

## **Prevention**

- The most effective measure is to plant powdery mildew resistant cultivars of roses and other plants where they are available.

## **Monitoring**

### **Visual Inspections**

- Look for small, light-coloured patches on leaves and on growing tips, stems and flowers. In later stages, the patches grow together, covering the plant tissue with a powdery white growth. Plant shoots and flowers may be distorted or discoloured (often a reddish or purplish colour). Infected area of leaves may later die and turn brown.

### **Treatment Thresholds**

- Most trees are not significantly harmed by powdery mildew unless they have been repeatedly infected for several years.
- Moderate levels of infection may not require treatment especially if they occur late in the season or on isolated plants or in Class B or C sites.

- Highly susceptible plants, such as some cultivars of euonymus and roses, in high profile (Class A) sites may require treatment with fungicides at the earliest sign of the disease.

• Top

## **Treatment**

### **Cultural Control**

- Don't over fertilize or over water plants. This produces excessive new growth and young tissue, which is the most susceptible to infection.
- Prune trees and shrubs to improve air circulation and reduce shade.
- Clean up dead leaves and foliage around plants in the fall to remove overwintering sites for the fungus.

### **Physical Control**

- Prune out infected plant material and dispose of it.
- Syringe plants with water in mid-afternoon to stop spores from germinating.

### **Chemical Control**

- Lime sulphur can be applied during the dormant season.
- Sulphur, copper, benomyl, triforine and other fungicides are registered for control of powdery mildew during the growing season.

A baking soda and horticultural oil spray developed at Cornell University has had promising results in some conditions but is not a legally registered fungicide in Canada (for more information, see the Nursery and Landscape Pest Management and Production Guide). Control of powdery mildew has also been observed where anti-transpirant products containing non-toxic polymers have been applied to plants [see Quarles (2000), below].

• Top

## **ANTHRACNOSE (*Discula* spp.)**

Many different species of fungi cause anthracnose disease of landscape trees. The *Discula* spp. are of concern in coastal areas, where they cause anthracnose on ash (*Fraxinus* spp.) and on dogwood (*Cornus* spp.). Other species affect sycamore, maple and oak. Symptoms appear as large irregular blotches on leaves. In severe infections, cankers may develop on twigs or stems and trees may be partly or entirely defoliated.

The fungus overwinters in buds and bark of trees, in cankers on stems and on fallen leaves. It produces spores in wet weather in the spring, which are spread by both wind and water to infect nearby foliage. From leaves, the fungi move into the stems to form a canker. Where cankers girdle the trunks or repeated severe infections weaken trees (as can occur in dogwood anthracnose) the tree may eventually die.

## Prevention

- Avoid planting highly susceptible cultivars, such as Modesto ash (*Fraxinus velutina* 'Modesto') and Pacific dogwood (*Cornus nuttallii*).
- Choose more resistant species and cultivars, such as Japanese dogwood (*Cornus kousa*), Eastern dogwood (*Cornus florida*) or *Cornus* 'Eddie's White Wonder'.

## Monitoring

Visual Inspections:

- On dogwood, look for wedge-shaped blotches or irregular areas of dying tissue on leaves and twigs in late spring and early summer.
- On ash, look for leaf blotches and a scorched appearance around leaf edges.

• Top

---

## Action Decisions

- Costs of control measures are not likely to be justified unless the disease occurs every year.
- On susceptible dogwoods, remove all infected plant parts as soon as leaf blotches or stems cankers are found and apply protectant fungicides if required.
- For nursery plants and other high value (i.e., Class A) sites with a previous history of anthracnose, protectant fungicides may be warranted; treatments should start at budbreak and continue at 1-2 week intervals during wet weather.

## Treatments

### Cultural / Physical Controls

- In spring, remove infected leaves (on small, isolated plants) as soon as detected.
- Rake up and burn fallen leaves to remove overwintering spores.

### Chemical Control

- Dormant sprays of lime sulphur are available.
- Growing season sprays of chlorothalonil or mancozeb are registered for use.

• Top

---

## Further Reading

\_\_\_\_\_. APS Plant Disease Compendia (Specific titles: Conifers; Apples and Pears; Stone Fruit; Flowering Potted Plants; Rhododendrons and Azaleas; Roses; Chrysanthemums; Turfgrass; others). APS Press. (From: American Phytopathological Soc., 3340 Pilot Knob Road, St. Paul, MN 55121-2097. Web: <http://www.apsnet.org/>)



\_\_\_\_\_. 1998. Nursery and Landscape Pest Management and Production Guide. BC Ministry of Agriculture, Food and Fisheries and BC Landscape & Nursery Association (From: BCLNA, Suite 101, 5880-176A St., Surrey, BC V3S 4E3. Tel: 604-574-7772)

\_\_\_\_\_. 1997. Plant Health Care for Woody Ornamentals: A Professional's Guide to Preventing and Managing Environmental Stresses and Pests. International Soc. Arboriculture and University of Illinois. 223 pp. (From: University of Illinois, ITCS, 1401 South Maryland Drive, Urbana, IL 61801. Tel: 800-345-6087 Web: <http://www.extension.uiuc.edu/pubs.html>)

\_\_\_\_\_. 2000. Tree Fruit Production Guide for Commercial Growers, Interior Districts. Min. of Agriculture, Food and Fisheries and BC Fruit Growers' Assn. (From: BCFGA, 1473 Water St., Kelowna, BC V1Y 1J6. Tel: 250-762-5226)

Bobbitt, V., A. Antonelli, C. Foss, R. Davidson, R. Byther and R. Maleike. 1999. Pacific Northwest Landscape IPM Manual. Washington State University. 206 pp. (From: WSU, Cooper Publications Bldg., P.O. Box 645912, Pullman, WA 99164-5912. Tel: 1-800-723-1763 Web: <http://pubs.wsu.edu/cgi-bin/pubs/index.html>)

Dreistadt, S. H. 1994. Pests of Landscape Trees and Shrubs: An Integrated Pest Management Guide. Pub. # 3359, University of California. 327 pp. (From: ANR Publications, Univ. of Calif., 6701 San Pablo Ave., Oakland, CA 94608-1239. Tel: 800-994-8849 Web: <http://anrcatalog.ucdavis.edu/>)

Gerber, H. S., D. J. Ormrod and M. A. Waring. 1995. A Gardener's Guide to Pest Prevention and Control in the Home and Garden. BC Ministry of Agriculture, Food and Fisheries. 175 pp. (From: Crown Publications, 521 Fort Street, Victoria, BC V8W 1E7. Tel: 250-386-4636 Web: <http://www.crownpub.bc.ca>) [Revised edition available Fall 2000]

Olkowski, W., S. Daar, & H. Olkowski. 1991. Common Sense Pest Control. Taunton Press, Newtown, CT. 715 pp. (From: Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707. Tel: 510-524-2567 Web: <http://www.birc.org/>)

Quarles, W. 2000. Antitranspirants as Least-Toxic Fungicides. The IPM Practitioner. Vol. XXII (1): 1-9. (From: Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707. Tel: 510-524-2567 Web: <http://www.birc.org/>)

Pirone, P.P. 1978. Disease and Pests of Ornamental Plants. 5th ed. John Wiley & Sons, Toronto. 566 pp.

• Top \_\_\_\_\_

### **Study Questions**

1. Why are plant diseases often difficult to diagnose? Give two reasons.
2. Why is it important to keep weather records as part of a monitoring program for many plant diseases?
3. Answer true or false for the following:
  - \_\_\_\_\_ Sanitation pruning is done to remove infected plant parts.
  - \_\_\_\_\_ Knowing what the weather conditions have been, can help diagnose diseases caused by fungi.
  - \_\_\_\_\_ Spraying water onto leaves can stop powdery mildew spores from germinating.



\_\_\_\_\_ Cherry trees with symptoms of Little Cherry Virus should be sprayed immediately to kill the virus.

4. Why is timing very important for application of preventative (protectant) fungicides?
5. List three things to check for in a follow-up inspection after treatment for a plant disease.

[Return to Table of Contents](#)

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.



## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

#### Chapter 11 — Safe Use Guidelines for Landscape Pesticide Treatments

##### *Learning Objectives*

When you have completed this lesson, you should be able to:

1. *List four general precautions that apply to most landscape pesticide applications.*
2. *Describe specific precautions for preventing bystander exposure.*
3. *Describe guidelines to prevent contamination of land and water adjacent to treatment areas.*
4. *Describe precautions to prevent accidental release of pesticide.*
5. *Describe authorizations and recommended notifications required for public land treatments.*
6. *Describe authorizations and recommended notifications required for private land treatments.*
7. *Describe professionalism as it applies to using pesticides.*

When, in the course of an IPM program, a decision is made to use a pesticide, pest managers must choose the best formulations and application methods for the situation. They must also take all possible precautions to prevent the exposure of people and non-target organisms to the pesticide. Ways to limit negative impacts of pesticides include:

- Select the least-toxic pesticide that will do the job; if possible use a "preferred pesticide" as defined in this manual (see Chapter 3).
- Use application methods that minimize pesticide drift or spread in the environment.
- Limit treatments to only the plants or sites where pests are a problem (e.g., use spot treatments).
- Take precautions to prevent exposure of humans and non-target organisms to pesticides.

[Top](#)

##### *Precautions for Using Pesticides in Landscapes*

###### **Protecting Bystanders from Pesticides**

What precautions to take to prevent exposure of bystanders to pesticides depends on the type of site. For example:

- Post public areas with notices stating where treatments are planned and have occurred (see text box on Guidelines for Pesticide Treatment Notices).
- Apply pesticides during periods of lowest public activity, if possible (i.e., during weekends for school grounds; in the early morning for parks).
- Avoid spraying areas near public roadways where school children may be present. This is usually from 7:30 to 9:00 a.m. and 2:30 to 4:30 p.m.
- Tell owners or occupants of private land what precautions they must take to prevent exposure (see below for details).

### **Preventing Contamination of Adjacent Land and Water Bodies**

Pesticides must not be allowed to drift, run off or leach onto land or water bodies bordering treatment areas (see text box on How to Avoid Pesticide Drift). A suitable buffer distance must be left between the treatment area and adjacent areas to be protected.

- No spray droplets should fall on adjacent properties, where treatments are not authorized. Areas of particular conflict are where the adjacent land has:
  - cultivated plants grown for human consumption
  - plants sensitive to herbicide drift
  - trees or shrubs that may be damaged by herbicides leaching to roots areas where children play

#### **How to Avoid Pesticide Drift**

- Use equipment least likely to produce drift. For example, use wipe-on or wick applicators for herbicides and use low pressures and coarse spray nozzles for sprayers.
- Do not spray in windy conditions, which generally means when wind speeds are greater than 8 km / hour.
- Apply volatile compounds during periods of relatively high humidity with moderate temperatures, preferably when there is a light breeze to help disperse vapours quickly.

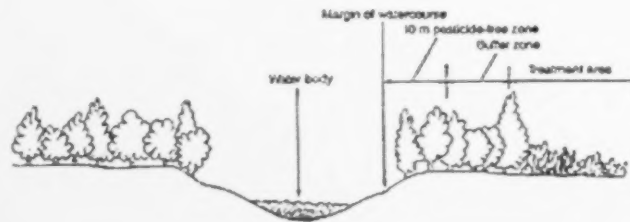
- Do not contaminate domestic water supplies. Pesticides should not be mixed or applied, and application equipment should not be washed, within 30 m of wells or ponds used for domestic water supplies.
- Do not contaminate fish bearing waters directly or indirectly by runoff, leaching or drift.
- Leave enough distance between the treatment area and water body to prevent movement of pesticides into both the water and the riparian (riverbank) zone next to the water body (see text box on Setback Distances for Water Bodies).
- Do not let equipment rinse water and excess chemicals run into sewers or ditches with water in them. Rinse water should be put into spray tanks and applied to the treatment area. Otherwise, it must be disposed of as a hazardous waste through a hazardous waste disposal company.

• Top

### Setback Distances for Water Bodies

It is an offence under the federal *Fisheries Act* to introduce any material into water that may be harmful to fish or fish habitat. To protect these waters, landscape applicators must determine a suitable setback distance between the area to be protected and the area where pesticide treatments are planned. The protected area includes the water body as well as adjacent riparian (riverbank) areas that contribute to fish food and habitat.

An example of a setback distance is the Ministry of Environment, Lands and Parks' (now called Water, Land and Air Protection) requirement in pesticide use authorizations for public land. A standard requirement is a 10-m pesticide free zone adjacent to the water body, with an additional buffer zone beside that. The 10-m pesticide free zone must not receive any pesticide spray drift, run off or leachate. The buffer zone must be a suitable width to prevent any release of pesticide into the pesticide free zone. The pesticide free zone can only be made narrower in cases where the ministry is confident that the water body and riparian areas are adequately protected from pesticide contamination.



Relation between a 10 m pesticide-free zone (PFZ), buffer zone and treatment area.

### Protecting Non-target Vegetation for Herbicides

Precautions must be taken to prevent herbicides from being carried to the roots of non-target plants. This applies particularly to trees because their roots usually extend a considerable distance from the trunk.

- Follow herbicide label directions if it specifies a buffer zone distance between the treatment area and non-target plants.
- If not specified on the label, herbicides should be applied no closer than one metre out from the drip line of trees. The drip line is the outer edge of the leaf canopy, where water drops from the foliage and where a tree normally has many roots.
- Non-selective residual herbicides should be applied no closer than a distance that is equal to two times the height of a tree (measured from the base of the trunk).
- Further distances from plants may be required depending on the sensitivity of the plant to herbicides, the soil type and the herbicide used.

### Preventing Accidental Release of Pesticides

- Keep spray equipment (power hoses, backpacks, etc.) locked in vehicles or compartments of service trucks when not in use and during transport.
- Be prepared to handle pesticide spills and other emergencies. Have a pesticide spill kit and emergency phone numbers readily available.
- Never dispose of pesticides, empty containers or excess mixed pesticide on the property or leave them behind for the client to deal with.

### Preventing Property Damage from Pesticides

- Some pesticides can stain stucco and siding or cement sidewalks. Where there is a possibility that spray could land on such surfaces, check labels for precautions. If in doubt, test spray before applying the pesticide to the treatment area.

• Top

## ***Public Land: Authorizations and Notification***

Public lands are defined as land, buildings or facilities operated wholly or in part, by or for, a provincial government, city, municipality, regional district or other public agency such as a public school, college, university or hospital. All use of pesticides in such landscapes must be approved under the terms of a Service License issued by the Ministry of Environment, Lands and Parks (now Water, Land and Air Protection) (licenses are issued by regional offices in Nanaimo, Surrey, Kamloops, Nelson, and Prince George). Note that in some municipalities, bylaws restricting pesticide uses or requiring specific notification measures may be in effect.

Contractors working for municipalities and other agencies must follow the terms attached to the agency's Service Licence. For example, contractors working for municipalities that have IPM plans or that are operating according to a provincial IPM standard must comply with the terms of the municipality's plan or standards. Staff applying pesticides should have copies of the IPM plan or other standards that apply to their work with them on the job and must know what pesticides are authorized for use.

Remember that municipal boulevards, and roadside rights-of-way are public lands. As such, they cannot be treated with pesticides by the property owners or by private service companies unless authorized by the Ministry of Environment, Lands and Parks (now Water, Land and Air Protection) (e.g., through terms on Pest Control Service License or under a Pest Management Authorization). For pesticide use on municipal lands, ministry authorization would only be given with approval from the municipality.

Wherever people or pets could enter a pesticide treated area, such as parks and boulevards, notices should be posted to alert people and warn them of any precautions they should take (see text box on Guidelines for Pesticide Treatment Notices).

### **Guidelines for Pesticide Treatment Notices**

#### **What notices should look like:**

- rectangular in shape and at least 25 cm x 35 cm
- made of rain resistant materials, where applicable
- type or letters should be large and clear enough to be read easily
- include a cautionary symbol, such as a raised hand inside a red "stop sign" shape

#### **What notices should contain:**

- date of treatment
- common name of pesticide used
- description of area treated
- recommended unprotected re-entry time (if applicable)
- other advice or precautions as appropriate
- name and telephone number of the service license or responsible person who applied the pesticide(s)

**Where to place notices:** In general, notices should be placed in high visibility locations where they can be seen both from inside and outside of the treated area. Specific tips include:

- For treatment areas greater than 0.8 hectares in size, post notices at all major public entry points. Where there is no fence or gate to control public access, post notices at intervals of 15 m or less.
- For treatment areas less than 0.8 hectares in size, post notices around the outside edge of the treatment area, using at least one sign in the centre of each side of the treatment area.
- For boulevard trees or turf, post notices at the beginning and end of the treated area and at 20 m intervals along the boulevard.

**When to post notices:**

- Post notices on the site at least 24 hours before the pesticide is applied.
- Leave notices up for at least 48 hours following the pesticide application, then remove them.

[Top](#)

### ***Private Land: Authorizations and Notification***

Private landscapes include those around multiple, double and single family dwellings. Of course, any pesticide use on private land requires the consent of the land owner. Tenants or other residents of the property should also be notified and, ideally, their consent should be obtained. Common problems that arise over pesticide use in such landscapes revolve around communications between the applicator and the residents or landowners. Suggestions for improving these communications include:

- For apartment houses and multiple family homes, inform the landowner, property manager or other relevant authority about any planned treatments.
- Ensure that the service licensee, the manager or their representatives, posts notices on the grounds at least 24 hours before treatment. Notices should stay up for at least 48 hours after treatment (see text box for recommendations on design and placement of notices).
- For one or two family homes, inform the owner or occupants before applying a pesticide to the grounds. Tell them as well that it is their responsibility to advise guests to avoid contact with treated areas. Provide information on the pesticide to be used, how long to wait before entering the treated area or walking on treated lawns and tell them of any other safety precautions that should be observed. Be prepared to give clients copies of Material Safety Data Sheets for all pesticides used, if asked for them.
- Direct tenants of buildings adjacent to areas to be sprayed to close their windows and doors until the application is finished and vapours disperse. Also direct them to keep domestic pets away from treated areas for a suitable period (generally until pesticides are dry).
- Where fruit-bearing trees or other food crops are treated, provide occupants with a specific notice of treatment, containing days-to-harvest information (if applicable) after treatment.

#### **When Is It Safe to Enter a Treated Area?**

In British Columbia, the Workers' Compensation Board (WCB) has established re-entry



intervals after pesticide applications for workers under their jurisdiction. These intervals are intended to reduce the potential for harm to workers. These are, at a minimum:

- 24 hours for a pesticide classified as slightly\* toxic,
- 48 hours for a pesticide classified as moderately\* or very\* toxic, or for a mixture in which a moderately or very toxic pesticide is present, or
- the interval specified on a pesticide label if that interval is longer than the intervals specified above.

Where WCB regulations do not apply, the re-entry instructions (if any) stated on a pesticide label are the only legal requirement. Label instructions may only indicate that the treated area should not be re-entered until the pesticide is dry. For example, a common diazinon product label states: "Keep children and pets off treated areas until spray has dried". How long it takes for a pesticide to dry depends on the temperature, relative humidity and wind conditions.

Decisions on when to re-enter a treated area should be conservative to ensure as little exposure as possible for people and pets. It would be advisable to increase re-entry times where the applicator, clients or site users have special concerns.

\* Classification of pesticides according to toxicity is specified in Section 6.7 of the WCB Health and Safety Regulation (1998). Briefly, slightly toxic products are those where the active ingredient has an oral LD50 over 500 mg/kg and a dermal LD50 over 1000 mg/kg. Moderately and very toxic pesticides have active ingredients with LD50s below these levels.

• [Top](#)

## ***Professionalism and Pest Management***

A professional is someone with a high level of knowledge and training, who conducts their work effectively, responsibly and safely. Landscape professionals should:

- have horticultural training and meet certification and licensing requirements for conducting business and for using pesticides (as applicable)
- belong to professional associations
- follow national or provincial standards such as the BC Landscape Standard (see Further Reading) and continue to work at improving their knowledge and skills
- have well-maintained and calibrated equipment
- look after the welfare of clients by ensuring that services are correctly performed, taking precautions to prevent bystander exposure to pesticides and protecting the environment
- be able to apply an IPM approach to managing landscape pests

### **Using Pesticides Professionally**

- Always have a valid Pesticide Applicator Certificate and Service License (as applicable). Have your Applicator Certificate wallet card with you on the job and be ready to show it if asked by a client or provincial inspector. Post the Service License at the office where records are kept.
- Know the federal and provincial regulations as well as municipal regulations, if any, that apply to your work and follow them.
- Keep clear and accurate pesticide records. Complete the Daily Operation Records at the time of each treatment application. Submit the Annual Summary of Operations records as required by the Ministry of Environment, Lands and Parks (now called Water, Land and Air Protection).



- Honour any guarantees and be prepared to back up claims you make for your work. Don't make claims for pesticides or other products that are not true.
- Follow recommended pesticide safety and handling practices, wear protective clothing, mix and use pesticide products only according to instructions on the label and protect the environment and non-target areas from exposure to pesticides. Dispose of rinse water, waste pesticides and pesticides containers as required by provincial laws.

### Communicating with Clients

When working with private residence clients, good communication is a vital part of a professional approach. Time spent in determining customer needs and informing them about IPM will be time well spent. For example, the idea of paying for monitoring, especially when it shows that no controls are needed, will be new to some people. By taking time to explain that inspections and monitoring are important parts of an IPM program your clients will realize that what they are paying for is the professional skill in maintaining plant health and a healthy landscape — not just for a pesticide application. Suggestions for other things to talk to clients about are:

- Before starting any work, make sure you understand exactly what the client or customer wants done. If their expectations are unrealistic or if unexpected problems arise, discuss the difficulty honestly with the client.
- Provide clear quotes and letters of agreement, describing the work accurately, the fees and expenses, work schedule, standards required and payment schedule.
- Provide clients with information about the IPM approach and benefits.
- Find out what they want their landscape to look like and whether the appearance of some parts of the landscape, such as the front yard, is more important than other areas. This will help in setting injury levels.
- Find out whether they have concerns about how pest problems are managed. For example, some clients do not want pesticides used in their landscapes or in some parts of it, such as on lawns where children play.
- Determine the budget the client has available for the work and adapt the service to fit their budget goals.
- Let them know what to expect from the different types of controls. For example, if biological controls are going to be released, make sure the client knows how they work and that it can take longer to see results than using pesticides.
- Explain the difference between damage that harms the plant and damage that affects the visual appearance temporarily, but does not cause long term harm to the plant. Most clients will tolerate minor injury if the plant is not at risk.
- After each visit, send or leave the client a written notice of work done and other key information about their landscape (see British Columbia Landscape Standard for sample site maintenance report forms and landscape monthly report forms).



By permission of BC Landscape and Nursery Association

• Top

### Further Reading

\_\_\_\_\_. 1997. British Columbia Landscape Standard. BC Society of Landscape Architects and BC Landscape & Nursery Assoc. 108 pp. (From: BCLNA, #101-5830 176A St., Surrey, BC V3S 4E3. Tel: 604-574-7772)

### Study Questions

1. Describe three precautions you could take to prevent exposure of bystanders to pesticides.
2. Why is it an offence under the federal *Fisheries Act* to introduce pesticides into water?

3. What is the purpose of posting pesticide treatment notices in parks and boulevards?
4. If you were treating the lawn of a private home, what should you tell the owner or occupants before applying a pesticide to the grounds?

[Return to Table of Contents](#)

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.



## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

---

#### Glossary

---

**Annual plant** - a plant that germinates from seed, flowers, produces seed, and dies in the same year; it has a one-year life cycle.

**Application rate** - the amount of a pesticide product or active ingredient applied to control a pest. It is usually expressed as amount per area (e.g., 30 ml per 10 m<sup>2</sup>), per length of crop row (e.g., 40 g per 10 m length of row) or as a dilution (e.g., mix 50 ml in 4 L of water and spray to thoroughly wet foliage).

**Bacteria** - one-celled micro-organisms, some of which cause diseases in plants, insects or other animals. They can only be seen with a microscope.

**Biological control** - the use of beneficial species, such as predatory and parasitic insects, birds, nematodes, or disease organisms to suppress populations of pests.

**Broadcast application** - an even application of a pesticide over an entire area, as opposed to treating part of the area or only individual plants in the area.

**Broadleaf plants** - most annual and perennial plants, shrubs and trees with wide leaves. Not grasses, conifers or other plants with needles or grass-like leaves.

**Broad-spectrum pesticide** - a pesticide that will kill, or affect, a wide range of organisms in addition to the target pests. The opposite of a selective pesticide.

**Caterpillar** - generally the larval, or immature stage of moths and butterflies (*Lepidoptera*).

**Contact pesticide** - a compound that causes the death of an organism when it comes in contact with it; the pesticide does not need to be eaten or inhaled by the organism to be effective.

**Deciduous plants** - plants that lose their leaves in the fall and have bare branches in the winter.

**Defoliation** - the loss of leaves from trees, shrubs or other plants, e.g., caused by feeding from leaf-chewing pests or by injury from herbicides.

**Dormant / dormancy** - the seasonal halt to visible growth in plants or activity in animals, usually for the winter season.

**Ecosystem** - an ecological system that includes a community of interacting living organisms along with the environment they live in.

**Fatty acids** - organic (containing carbon and hydrogen) chemical acids that occur naturally in waxes, fats and essential oils; a component of some low toxicity pesticides.

**Formulation** - a mixture of active ingredient(s) with carriers, spreaders or other materials, to improve the storage, mixing and / or application properties of a product.

**Fungi** - a group of often microscopic organisms lacking chlorophyll (green colouring); they grow from microscopic spores. Many fungi cause plant diseases, such as rots, rusts, mildews and blights; some species of fungi attack wood or cause decay in buildings and others cause diseases in insects. (Singular: fungus)

**Fungicide** - a pesticide used to control fungi that cause plant diseases.

**Geotextiles** - synthetic fabric for use in landscapes as a soil covering to smother weeds or prevent them from germinating.

**Grub** - the larval stage of some beetles.

**Herbicide** - a pesticide used to kill plants and control vegetation.

**Honeydew** - sticky liquid excreted by aphids as they feed on plants.

**Host** - with respect to pests, hosts are the living organisms that a pest or parasite depends upon for survival.

**Insects** - an enormous group of organisms with hard exterior skeletons; the adults have a body divided into three segments (head, thorax and abdomen), with 3 pairs of legs and 1-2 pairs of wings (if present) attached to the thorax.

**Insecticide** - a pesticide used to kill or repel insects.

**Integrated pest management (IPM)** - a decision making process for managing pest populations that uses a combination of techniques; it includes preventing pest problems, identification, monitoring, use of injury thresholds for decisions, a combination of controls (cultural, physical, mechanical, biological, chemical, etc.) and an evaluation step.

**Larva** - the immature, second life stage of an insect; a larva hatches from an egg. Most are wormlike, such as caterpillars, maggots and grubs. Many pest insects cause the most damage in the larval stage, particularly those that eat plants. (Plural: larvae).

**Maggot** - the larval stage of flies and midges (Order *Diptera*). Maggots are legless.

**Microbial insecticide** - a biological pesticide that contains microorganisms, such as bacteria, viruses or fungi, that attack insects.

**Mites** - minute animals having eight legs in the adult stage. There are harmful and beneficial species, closely related to spiders.

**Miticide** - a pesticide used to kill or repel mites.

**Molluscs** - a group of soft-bodied animals, most of which live in water and have shells, such as clams, oysters and mussels; some, like snails and slugs live on land; slugs are molluscs with no shell.



**Molluscicide** - a pesticide used to control snails and slugs (molluscs) pests.

**Nematodes** - a group of elongated, cylindrical worms, also called thread-worms or eel-worms. Some species attack roots or leaves of plants, others are parasites on animals or insects.

**Non-selective pesticide** - a product that kills or controls a wide range of organisms or related organisms; e.g., a non-selective herbicide is one that would kill many types of plants.

**Parasite** - an organism that lives in or on the body of another organism and obtains nourishment from it.

**Perennial** - a plant that has a life-span of more than two years. The top may die back in winter or in drought, but the roots or rhizomes persist to resume growing in favourable conditions.

**Persistent pesticide** - a pesticide that takes along time to degrade into simple compounds after being released into the environment; particularly those applied to soil that last more than one growing season (see Residual pesticide).

**Pests** - living organisms, such as insects, weeds, fungi, rodents, and others, that cause damage, irritation or are otherwise troublesome or harmful.

**Pesticide** - any substance or material, other than a device, that is sold or used to destroy, repel or manage a pest.

**Phenology** - the relationship between the climate and biological events, such as flowering or leafing out in plants.

**Pheromone** - a chemical compound given off by an insect to communicate with other insects of the same species (see also: Semiochemicals).

**Phytotoxic** - damaging or injurious to plants, often by destroying the protective surface on plant leaves.

**Post-emergence** - stage in a plant life-cycle after seedlings emerge from the soil surface.

**Pre-emergence** - stage in a plant life-cycle before seedlings emerge from the soil surface.

**Predator** - a living organism that preys upon another animal. Many birds are predators of insects; many species of insects and mites prey upon other insects.

**Pupa** - the stage between the larva stage and the adult in insects that undergo complete metamorphosis; a non-feeding and usually an inactive stage. (Plural: pupae).

**Quantitative measurement** - provides information in terms of numbers, proportions or other quantities.

**Random sampling** - collecting samples based on chance, rather than on making conscious choices for each sample; ensures that the samples collected are likely to show an accurate estimate of the situation.

**Residual pesticides** - products that continue to have a killing or repellent effect for a period of time (e.g., weeks or months) after application.

**Selective pesticide** - a material that destroys or repels a limited group of organisms; e.g., a selective herbicide may kill broadleaf weeds in a lawn, without injuring the grass plants.

**Semiochemicals** - "message chemicals" that are used by insects as signals; some are produced by plants and attract or repel insects, others are produced by insects to communicate alarm or attract mates.

**Spot treatment** - an application of a pesticide to localized or restricted areas (e.g., individual plants) as opposed to a broadcast treatment that involves a uniform application over an entire field or area.

**Systemic pesticide** - a product that is absorbed into the plant and moves through the plant tissues; e.g., a systemic insecticide can move throughout a plant to kill sucking insects.

**Thatch** - in lawns, this is a layer of dead plant material at the roots of the grasses; a certain amount is beneficial in protecting roots from heat, cold and drought, whereas a thick layer smothers roots and blocks fertilizer and water from reaching the soil.

**Toxic** - able to poison a living organism; poisonous.

**Toxicity** - the degree to which substance is poisonous or injurious to a plant or animal. Toxicity is one consideration in assessing the hazard in handling a particular pesticide.

**Virus** - a protein body capable of infecting and multiplying like living organisms within a host plant or animal; usually causing disease.

[Back to Table of Contents](#)

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.



## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

#### Answers to Study Questions

##### *Chapter 1. What is Integrated Pest Management?*

1. b, d, g, e, a, c, f

2. Any four of the following: provide long-term solutions to pest problems; protect the environment and human health by reducing pesticide use; reduce costs and liabilities associated with pesticide use; prevent pesticide resistant pests from developing; enable pest managers to control pesticide resistant pests; give good results where pesticides cannot be used.

3. At it's most basic, prevention means choosing the right plants for the site and giving them the best growing conditions.

4. Identification identify the pest; monitoringmonitor the pest population and/or damage; action decisionsuse injury and action levels to decide when to treat; treatmentsapply a variety of controls; evaluationevaluate results, plan improvements.

5. c) Environmental conditions

6. Monitoring is used to: detect problems while pest numbers are still low; assess the size and spread of a pest population and extent of damage; find out if natural enemies of pests are present and in what numbers; look for conditions that contribute to the pest problem; find out what effect treatments or natural enemies have had on the pest population.

7. Most pheromone traps contain synthetic sex pheromones to attract male moths; traps are used to find out when the main flights of adult moths occur so that sprays or biological controls can be used at the right time to have the greatest effect.

8. The injury level depends on factors such as: what part of the plant is affected; what pest is involved and the risk of permanent injury or death to the plant; overall health of the affected plant; location of the plant in the landscape; attitudes of people who use the site; cost and effect of treatments.

9. Five general types of controls are cultural, physical, mechanical, biological, and chemical.

10. Evaluation helps the pest manager: determine what worked and what didn't; identify ways to improve the program; assess the costs and benefits of the program; identify changes to site design and management to prevent future problems.

[Top](#)

## **Chapter 2: Moving from Theory to Practice**

1. Any 3: Choose one site; a small part of a large site; a limited number of small sites; site(s) with fewest pest problems; key pests; key plants.
2. It is easier to see where to concentrate efforts and to make decisions about managing pests.
3. Any 3: Life cycles and biology; range of host plants that may be affected; conditions that favour the pests; conditions that prevent pest development; natural enemies of the pests.
4. a. Types of information are: physical characteristics, plant inventory, use patterns, environmental concerns.  
b. This information will be useful in setting treatment thresholds and choosing treatments.
5. The injury levels should be reviewed regularly (usually annually) to fine-tune them in light of experience.

## **Chapter 3: Preferred Pest Controls**

1. a) High temperatures tear apart plant cells and destroy proteins in the cells;  
b) flamers, hot water/steam applicators, infra-red radiation applicators.
2. a) Mulches suppress weeds by depriving them of the light they need to grow;  
b) mulches should be applied as soon as the soil is cultivated or disturbed because weed seeds brought to the surface start to germinate immediately.
3. Nematodes are generally not effective in dry soil conditions and cool conditions.
4. F, T, F, T
5. a) Oils act upon contact, by suffocation and by disrupting other physical processes.  
b) Tebufenozide mimics the action of insect moulting hormones, causing larvae to stop feeding within hours.  
c) Sulfur particles bind with fungal spores to prevent their germination.
6. Botanicals are pesticides derived from active compounds found in certain plants. Examples (any two): pyrethrins, rotenone, neem (not yet registered in Canada).

[Top](#)

## **Chapter 4: IPM for Vegetation**

1. Any 3 of the following: Install a mow strip; extend asphalt surfaces past the outside edge of fencing; install brick-patterned surfaces instead of bricks or paving stones; fill cracks with sealant.
2. This information will help in deciding the best management methods and when to use them.
3. a. Which method of monitoring to use depends on the site and the user.  
b. How often to monitor depends on the category of the site, its history of weed problems and the

local climate, as well as the budget.

4. Three main factors to consider in setting injury levels for problem vegetation are: a) safety and security of site users; b) potential for damage to structures and facilities; c) aesthetic standards.

5. This is when nutrient reserves in the roots are at their lowest and the plant is least able to grow new leaves.

6. F,T,F,T

### ***Chapter 5: IPM for Weeds in Turf***

1. Given good conditions, vigorous turf will outgrow most other kinds of plants.

2. F, F, T, T

3. Transect method; grid method; centerline method

4. a, c, b

5. To control annual weeds, focus on preventing seeds from spreading and preventing dormant seeds in the soil from germinating.

[Top](#)

### ***Chapter 6: IPM for Insects in Turf***

1. Any 3 of the following: Damaged areas; signs that birds or other animals are pulling up the turf; life stages of insects; symptoms of chewing or sucking; silken webbing in the thatch layer.

2. Soap drenches are most useful for active insects and larvae, such as leatherjackets and sod webworms.

3. d

4. Avoid broadcast applications of insecticides because they have been shown to reduce the natural populations of beneficial insects and mites that feed on turf pests.

### ***Chapter 7: IPM for Diseases in Turf***

1. c, a, e, b, d

2. Dew gives fungi a food supply (from guttation water) and also allows the pathogens to move on a film of water to nearby plants.

3. Diseases are often difficult to diagnose because different diseases have similar symptoms; because symptoms may be mistaken for injury resulting from poor growing conditions or physical injury.

4. The monitoring schedule depends on: category of the site, on how susceptible the turfgrass is to diseases, and on weather conditions.

5. Contact fungicides, Disadvantage: they do not provide long lasting protection; Systemic fungicides, Disadvantage: development of resistance.

• Top

### **Chapter 8: IPM for Insects & Mites in Greenhouses and Nurseries**

1. Because many greenhouse and nursery plant pests are extremely small and hard to see.
2. a) spider mites; b) sucking insects on the foliage above; c) root weevils
3. Any 3 of the following: How much damage the public will tolerate; whether the pest is likely to spread to other stock; what effect it could have on the growth rate or long-term health of the plant; the age of the plants; the category of site.
4. Control weeds both in, and around, greenhouses; maintain at least a 3m wide, closely mowed strip around the outside perimeter of production greenhouses and nurseries; drain all wet spots in greenhouse benches, floors and between nursery rows.
5. Before placing an order, always consult the supplier of biological controls to make sure you order the right species and know how to use them.
6. Either of the following: it is usually difficult to keep people out of such sites long enough to ensure sufficient ventilation after an application; commercially available biological control agents are effective for many indoor pests, but most cannot be used while pesticide residues are present on plants.

• Top

### **Chapter 9: IPM for Insects & Mites on Trees & Ornamentals**

1. Any 4 of the following: Higher temperatures; less air flow; more disturbed and compacted soils; winter road salt; air pollution from traffic exhaust.
2. Because the total cost of managing pests on susceptible plants can be very high over the lifetime of the planting.
3. To use indicator plants for monitoring, a pest manager must know what pests to expect and which particular plants are usually attacked first.
4. e
5. One answer under each of the following:
  - a) aphids, spider mites and some sawflies (such as roseslug and pearslug)
  - b) winter moth, elm leaf beetles, ants
  - c) leaf-feeding caterpillars

• Top

### **Chapter 10: IPM for Diseases in Trees & Ornamentals**

1. two of the following: Because different diseases have similar symptoms; because symptoms may

be mistaken for injury resulting from poor growing conditions; because symptoms that appear on one part of a plant can be caused by a pathogen attacking another part of the plant.

2. Humidity and temperature are key factors in the development of many diseases. Weather records will help you know when conditions have been favourable for specific bacterial or fungal disease infections so that you can monitor or treat accordingly.

3. T, T, T, F

4. Timing is important because they have little effect if applied after the infection period has ended.

5. Check for: further spread of disease symptoms; reduction or elimination of disease symptoms; restoration of plants to normal growth or appearance.

[Top](#)

### ***Chapter 11: Safe Use Guidelines for Landscape Pesticide Treatments***

1. Any three of the following: Post public areas with notices indicating where treatments are planned and have occurred; apply pesticides during periods of lowest public activity; avoid spraying areas near public roadways where school children may be present; tell owners or occupants of private land about precautions they must take to prevent exposure.

2. Because they may be harmful to fish or fish habitat.

3. The notices alert people and warn them of any precautions they should take.

4. Tell them it is their responsibility to advise guests to avoid contact with treated areas; provide information on the pesticide to be used; tell them how long to wait before entering the treated area or walking on treated lawns; tell them of any other safety precautions that should be observed.

[Back to Table of Contents](#)

[Top](#) [Copyright](#) [Disclaimer](#) [Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.







## INTEGRATED PEST MANAGEMENT

### Integrated Pest Management Manual for Landscape Pests in British Columbia

---

#### Appendices

---

#### *Appendix I. Provincial Plant Diagnostic Lab Submission Form*

Go to: <http://www.agf.gov.bc.ca/cropprot/lab.htm>

#### *Appendix II. Examples of Forms Used in Landscape IPM*

##### A. Pest Identification Notice

##### B. Pest Treatment Notice

These reports are filled in by city landscape staff who submit the information to the city IPM Co-ordinator. Both forms ask for detailed information, using a simple check-off format as much as possible to make sure the facts needed to make decisions are available.

Both forms are used courtesy of Dr. Michelle Gorman, IPM Co-ordinator, City of Victoria, Engineering and Parks Department.

##### C. Sticky Card Counts

This form was designed for use in monitoring pests in bedding plant greenhouses, however, it could also be adapted for use in other ornamental greenhouses.

Each box on the form is used to record information from one yellow sticky card at four monitoring visits. Record the greenhouse, card number, card location (bench, floor, or ceiling), and make a note if the card is changed. If it is not, circle the counted insects so they will not be included at the next monitoring visit. Record the number of insects on the card in the appropriate column; WF = whitefly; FG = fungus gnat; SF = shorefly. To avoid confusion, write "0" rather than leaving a blank when no insects are present.

Form is excerpted from Integrated Pest Management for Bedding Plants: A Scouting and Pest Management Guide. 1998. Ed: Christine Casey. Cornell University and the New York State IPM Program. Available at: <http://www.nysipm.cornell.edu/publications/bpguide98/contents.html>.

Top

A. Pest Identification Notice

CITY OF VICTORIA, PARKS DEPARTMENT  
WEED IDENTIFICATION NOTICE/BOULEVARDS

Reported by \_\_\_\_\_ Date \_\_\_\_\_

Location of Weed Problem (address) \_\_\_\_\_

\_\_\_\_ Initial Report      \_\_\_\_ Follow-up Report      \_\_\_\_ 2nd Follow-up Report

Date Reported to IPM Coordinator \_\_\_\_\_

(Per unit area ie. 10 m x 10 m = 100 m)

| Weed Species | % Weed Cover/Species | % Total Weed Cover |
|--------------|----------------------|--------------------|
|              |                      |                    |
|              |                      |                    |
|              |                      |                    |
|              |                      |                    |
|              |                      |                    |
|              |                      |                    |
|              |                      |                    |

Percentage of Woods with Flowers or Seed Heads \_\_\_\_\_

Fertilizer Dates \_\_\_\_\_

Type of Fertilizer \_\_\_\_\_

Seed or Turf Type \_\_\_\_\_

Effective Cutting Height \_\_\_\_\_

Frequency of Mowing \_\_\_\_\_

Irrigated by \_\_\_\_\_

Date of Soil & Turf Sample \_\_\_\_\_

Frequency of Watering \_\_\_\_\_

Thatch Accumulation \_\_\_\_\_

Previous Herbicide History \_\_\_\_\_

White Copy: IPM    Yellow Copy: Deputy Superintendent    Pink Copy: Supervisor

Top

B. Pest Treatment Notice

City of Victoria, Parks Department Report Number \_\_\_\_\_

**Pest Identification Notice**

Reported by \_\_\_\_\_ Date \_\_\_\_\_

Date of consultation with IPM Coordinator \_\_\_\_\_

Location or Address \_\_\_\_\_

☐ Initial Report    ☐ Follow-up Report    ☐ 2nd Follow-up ReportPest Type: ☐ Insect    ☐ Mite    ☐ Fungi    ☐ Weed    ☐ Animal  
☐ Virus    ☐ Bacteria    ☐ Physiological

Pest Name \_\_\_\_\_

Pest Life Cycle Stages Found \_\_\_\_\_

Pest Estimate: ☐ 1. Very few pests  
☐ 2. Pests present in moderate numbers  
☐ 3. Pests present in high numbers  
☐ 4. Pests present in very large numbersInfestation: ☐ 1. Evenly distributed over entire plant  
☐ 2. Mainly on the newer growth  
☐ 3. Mainly on the older growth  
☐ 4. Trunk, stems or branches  
☐ 5. RootsPlant Damage: ☐ 1. None  
☐ 2. Minimal  
☐ 3. Noticeable Damage  
☐ 4. Damage affecting growth  
☐ 5. Causing plant death

Description of the damage/infestation \_\_\_\_\_

Percentage of plants damaged/infested \_\_\_\_\_

Predators/Parasites present \_\_\_\_\_

Host Plant type: ☐ Herbaceous    ☐ Shrub    ☐ Tree  
☐ Deciduous    ☐ Evergreen    ☐ Turf Grass

Host plant common name \_\_\_\_\_

Genus \_\_\_\_\_ Species \_\_\_\_\_

Cultivar \_\_\_\_\_ Growth Stage \_\_\_\_\_

IPM Coordinator's comments \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

White: IPM    Yellow: Deputy Superintendent    Pink: Supervisor

LAPSH/EPD/ATC/MS/TS/DO

• Top \_\_\_\_\_

**C. Sticky Card Counts**

Cornell University IPM

## GREENHOUSE IPM PROGRAM

Sticky Card Counts

GROWER \_\_\_\_\_

| House | Card #   | (Bench Floor Ceiling) |        |        |    |    |       |
|-------|----------|-----------------------|--------|--------|----|----|-------|
| DATE  | Changed? | WF                    | Thrips | Aphids | FG | SF | Misc. |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |

| House | Card #   | (Bench Floor Ceiling) |        |        |    |    |       |
|-------|----------|-----------------------|--------|--------|----|----|-------|
| DATE  | Changed? | WF                    | Thrips | Aphids | FG | SF | Misc. |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |

| House | Card #   | (Bench Floor Ceiling) |        |        |    |    |       |
|-------|----------|-----------------------|--------|--------|----|----|-------|
| DATE  | Changed? | WF                    | Thrips | Aphids | FG | SF | Misc. |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |

| House | Card #   | (Bench Floor Ceiling) |        |        |    |    |       |
|-------|----------|-----------------------|--------|--------|----|----|-------|
| DATE  | Changed? | WF                    | Thrips | Aphids | FG | SF | Misc. |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |

| House | Card #   | (Bench Floor Ceiling) |        |        |    |    |       |
|-------|----------|-----------------------|--------|--------|----|----|-------|
| DATE  | Changed? | WF                    | Thrips | Aphids | FG | SF | Misc. |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |

| House | Card #   | (Bench Floor Ceiling) |        |        |    |    |       |
|-------|----------|-----------------------|--------|--------|----|----|-------|
| DATE  | Changed? | WF                    | Thrips | Aphids | FG | SF | Misc. |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |

| House | Card #   | (Bench Floor Ceiling) |        |        |    |    |       |
|-------|----------|-----------------------|--------|--------|----|----|-------|
| DATE  | Changed? | WF                    | Thrips | Aphids | FG | SF | Misc. |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |

| House | Card #   | (Bench Floor Ceiling) |        |        |    |    |       |
|-------|----------|-----------------------|--------|--------|----|----|-------|
| DATE  | Changed? | WF                    | Thrips | Aphids | FG | SF | Misc. |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |

| House | Card #   | (Bench Floor Ceiling) |        |        |    |    |       |
|-------|----------|-----------------------|--------|--------|----|----|-------|
| DATE  | Changed? | WF                    | Thrips | Aphids | FG | SF | Misc. |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |

| House | Card #   | (Bench Floor Ceiling) |        |        |    |    |       |
|-------|----------|-----------------------|--------|--------|----|----|-------|
| DATE  | Changed? | WF                    | Thrips | Aphids | FG | SF | Misc. |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |
|       | Y/N      |                       |        |        |    |    |       |

Notes: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

• Top \_\_\_\_\_

### Appendix III. Resources and Suppliers

Suppliers are listed for reader information only. Commercial suppliers known to the authors at the

time of publication are listed, however other suppliers may exist. The following listing does not constitute an endorsement by the ministry of services or products provided.

### **Websites**

BC Ministry of Environment, Lands and Parks (now called Ministry of Water, Land and Air Protection)  
For the on-line version of this and other IPM manuals, as well as additional reference on landscape pest management and pesticides, follow the links to the Integrated Pest Management home page at:  
<http://wlapwww.gov.bc.ca/epd/epdpa/ipmp/index.html>.

BC Ministry of Agriculture, Food and Fisheries  
For updates on the Nursery & Landscape Pest Management and Production Guide and other current nursery and landscape information follow the links to Reports & Publications at:  
[http://www.agf.gov.bc.ca/publicat/pubs\\_1.htm](http://www.agf.gov.bc.ca/publicat/pubs_1.htm).

Note: The internet has excellent web sites on IPM and landscape pest management too numerous to list. For hints to get started, see the IPM Program home page on the MELP web site (above) or search on keywords using an Internet search engine such as:  
Google <http://www.google.ca>  
Mamma <http://www.mamma.com> or others.

### **Suppliers of Biological Controls**

Applied Bio-Nomics Ltd.  
11074 West Saanich Rd.,  
Sidney, BC V8L 5P5  
Tel: 250-656-2123  
Fax: 250-656-3844  
E-mail: [bug@islandnet.com](mailto:bug@islandnet.com)

Koppert Canada Limited  
50 Ironside Crescent #2  
Scarborough, ON M1X 1G4  
Tel: (416) 291-0040  
(800) 567-4195  
Fax: (416) 291-0902  
E-mail: [pgoodspeed@koppertcanada.com](mailto:pgoodspeed@koppertcanada.com)

Nature's Alternative International Inc.  
1636 East Island Hwy  
NanOOSE Bay, BC V9P 9A5  
Tel: (250) 468-7911  
Fax: (250) 468-7900  
E-mail: [nai@bcsupernet.com](mailto:nai@bcsupernet.com)

WestGro Sales Inc.  
7333 Progress Way  
Delta, BC V4G 1E7  
Tel: (800) 663-2552  
(604) 940-0290  
Fax: (604) 940-0258  
E-mail: [westgro@westgro.com](mailto:westgro@westgro.com)

### **Suppliers of Monitoring Tools and Other Pest Management Products**

Cooper Mill Ltd.  
RR3, Madoc, ON K0K 2K0  
Tel: (613) 473-4847  
Fax: (613) 473-5080

Growers Supply Co. Ltd.  
2605 Acland Rd.  
Kelowna, BC V1X 7S4  
Tel: (250) 765-4500  
Fax: (250) 765-4545

Phero Tech Inc.  
7572 Progress Way  
Delta, BC V4G 1E9  
Phone: (604) 940-9944  
Fax: (604) 940-9433

WestGro Sales Inc.  
7333 Progress Way  
Delta, BC V4G 1E7  
Tel: (800) 663-2552  
(604) 940-0290  
Fax: (604) 940-0258

[Back to Table of Contents](#)

[•Top](#) [•Copyright](#) [•Disclaimer](#) [•Privacy](#)

GOVERNMENT OF BRITISH COLUMBIA

Please email: [site@gov.bc.ca](mailto:site@gov.bc.ca) with any comments or questions.